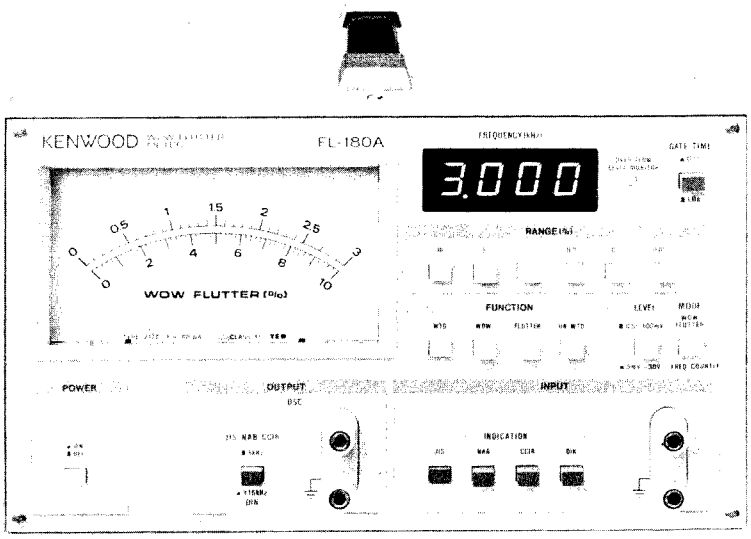
KENWOOD

WOW-FLUTTER METER

FL-180A

SERVICE MANUAL



WARNING

The following instructions are for use by qualified personnel only. To avoid electric shock, do not perform any servicing other than contained in the operating instructions unless you are qualified to do so.

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SPECIFICATIONS

WOW FLUTTER METER SECTION		
Measuring center frequency		Within 3 kHz ± 300 Hz (JIS, NAB, CCIR) Within 3.15 kHz ± 300 Hz (DIN)
Input level		0.5 mV ~ 100 mV, 5 mV ~ 30 mV, two ranges
Input impedance		300 kΩ ± 20%, unbalanced
Wow flutter measurement range		0.003 ~ 10% (5 mV ~ 30 V range) 0.01 ~ 10% (0.5 mV ~ 100 mV range) } 6 range
Display system		RMS value (JIS) Mean value (NAB) Peak value (CCIR, DIN)
Display accuracy		± 5% of full scale (at 4 Hz)
Frequency response	Weighted characteristics	In accordance with JIS, NAB, CCIR/DIN (at 0.2 ~ 200 Hz)
	Wow characteristics	0.5 ~ 6 Hz (− 3 dB ± 1 dB) (JIS/NAB) 0.3 ~ 6 Hz (− 3 dB ± 1 dB) (CCIR/DIN)
	Flutter characteristics	6 ~ 200 Hz (− 3 dB ± 1dB)
	Unweighted characteristics	0.5 ~ 200 Hz (− 3 dB ± 1 dB) (JIS/NAB) 0.3 ~ 200 Hz (− 3 dB ± 1dB) (CCIR/DIN)
	Roll off	Less than 0.5 Hz; more than − 6 dB/oct (JIS/NAB) More than 200 Hz; more than − 15 dB/oct (JIS/NAB) Less than 0.3 Hz; more than − 6 dB/oct (CCIR/DIN) More than 200 Hz; more than − 15 dB/oct (CCIR/DIN)
Maximum input voltage		100 V (DC + AC peak)
Input monitor		Level monitor lamp ON at more than 0.5 mV/5 mV of input
FREQUENCY COUNTER SECTION		
Measuring frequency range		0.01 ~ 55.00 kHz (gate time: 0.1 s) 0.010 ~ 9.999 kHz (gate time: 1 s)
Input level		100 mVrms ~ 30 Vrms
Input impedance		300 kΩ ± 20% (unbalanced)
Counting capacity		Decimal system, 4-digit LED memory display
Reference time	Reference time frequency	10.080 MHz (built-in crystal) AC power frequency (AC line power)
	Reference time frequency accuracy	$\pm 5 \times 10^{-5}$ (0 ~ 40°C) (built-in crystal) Refer to AC power supply accuracy. (AC line power)
Gate time		1 s, 0.1 s

SPECIFICATIONS

Measurement accuracy		± (1 digit + reference time accuracy)
Maximum input voltage		100 V (DC + AC peak)
Input monitor		Level monitor lamp goes on at 100 mV input or more. (Flickers if input frequency exceeds "9.999 kHz" with the GATE TIME button released. Turns off if input frequency exceeds 55.00 kHz beyond the measurement range with the GATE TIME button depressed.)
OUTPUT TERMINALS		
Recording output signal	Signal frequency	3 kHz, 3.15 kHz
	Accuracy	$\pm 5 \times 10^{-5}$
	Output voltage	0.2 Vrms ± 20% (open output)
	Output impedance	600 Ω ± 20% (unbalanced)
	Distortion factor	Less than 1% (600 Ω terminated)
Drift output terminal (DRIFT)	Output voltage	Approx. DC ± 1 V, for each ± 1% of frequency drift
	Output impedance	600 Ω ± 20% (unbalanced)
Scope output terminal (TO SCOPE)	Output voltage	Approx. 3 Vrms of full scale
	Output Impedance	600 Ω ± 20% (unbalanced)
Recorder output terminal (RECORDER)	Output voltage	Approx. DC 1 V of full scale
	Output impedance	600 Ω ± 20% (unbalanced)
POWER REQUIREMENTS		
Voltage		AC 100/117/220 ± 10%, 216 V ~ 250 V, 50/60 Hz
Power consumption		Approx. 14 W
OPERATING TEMPERATURE		0 ~ 40 °C
DIMENSIONS (W × H × D)		260 mm × 150 mm (171) × 305 mm (360) ( ) dimentions include protrusion from basic outline dimentions.
WEIGHT		Approx. 5.2 kg
ACCESSORIES		
Connecting cord with plugs and clips	(CA-36)	1 piece
AC cord		1 piece
Instruction manual		1 copy
Replacement fuse	(0.5 A)	2 pieces
	(0.3 A)	2 pieces

* Circuit and rating are subject to change without notice due to developments in technology.

SAFETY

SAFETY

Before connecting the instrument to a power source, carefully read the following information, then verify that the proper power cord is used and the proper line fuse is installed for power source. The specified voltage is shown at the fuse holder of the AC inlet. If the power cord is not applied for specified voltage, there is always a certain amount of danger from electric shock.

Line voltage

This instrument operates using ac-power input voltages that 100/117/220/240 V at frequencies from 50 Hz to 60 Hz.

Power cord

The ground wire of the 3-wire ac power plug places the chassis and housing of the oscilloscope at earth ground. Do not attempt to defeat the ground wire connection or float the oscilloscope; to do so may pose a great safety hazard. The appropriate power cord is supplied by an option that is specified when the instrument is ordered.
The optional power cords are shown as follows in Fig. 1.

Line fuse

The fuse holder is located on the rear panel and contains the line fuse. Verify that the proper fuse is installed by replacing the line fuse.

Voltage conversion

This oscilloscope may be operated from either a 100 V to 240 V, 50/60 Hz power source. Use the following procedure to change from 100 to 240 volt operation or vice versa.

1. Remove the fuse holder.
2. Replace fuse F 1 with a fuse of appropriate value, 0.5 amp for 100 VAC to 117 VAC operation, 0.3 amp for 220 VAC to 240 VAC operation.
3. Reinsert it for appropriate voltage range.
4. When performing the reinsertion of fuse holder for the voltage conversion, the appropriate power cord should be used. (See Fig. 1.)

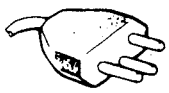
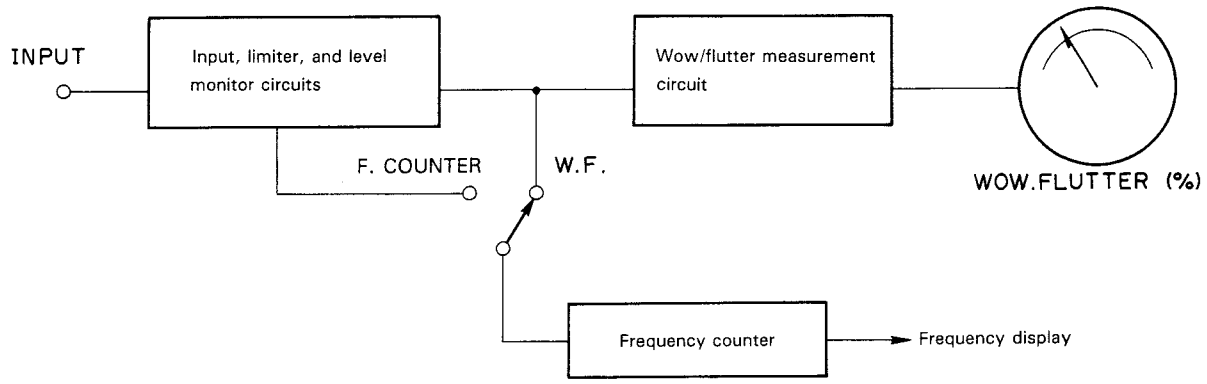
Plug configuration	Power cord and plug type	Factory installed instrument fuse	Line cord plug fuse	Parts No. for power cord
	North American 120 volt/60 Hz Rated 15 amp (12 amp max; NEC)	0.5 A, 250 V Fast blow 6×30 mm	None	Cord: E30-1820-05
	Universal Europe 220 volt/50 Hz Rated 16 amp	North Europe 315 mA, 250 V Slow blow 5×20 mm Other Europe 0.3 A, 250 V Fast blow 6×30 mm	None	Cord: E30-1819-05
	U.K. 240 volt/50 Hz Rated 13 amp	0.3 A, 250 V Fast blow 6×30 mm	0.8 A Type C	—
	Australian 240 volt/50 Hz Rated 10 amp	0.3 A, 250 V Fast blow 6×30 mm	None	Cord: E30-1821-05
	North American 240 volt/60 Hz Rated 15 amp (12 amp max; NEC)	0.3 A, 250 V Fast blow 6×30 mm	None	—
	Switzerland 240 volt/50 Hz Rated 10 amp	0.3 A, 250 V Fast blow 6×30 mm	None	—

Fig. 1 Power Input Voltage Configuration

CIRCUIT DESCRIPTION

The FL-180A consists of the three functional blocks shown below and in the block diagrams. It includes a frequency counter functional block, wow/flutter measurement functional block, and a functional block made up mainly of input, limiter and level monitor circuits.



1. INPUT CIRCUIT (SEE THE AMPLIFIER UNIT BLOCK DIAGRAM)

The input circuit generates the signals required by the operations for the wow/flutter and frequency counter functional blocks from input signals.

Input signals are amplified 100% (+40 dB) by FET (Field Effect Transistor) OP amplifier IC1. Diodes D2 and D4 function as the IC1 protector and limiter if the input signal is too large.

The output signal of the IC1 amplifier is transmitted to a band pass filter through an IC2. The band pass filter consists of three coils,L1 to L3, and four capacitors, C4 to C7, The IC2 is an amplifier with two different gains. This amplifier is connected with the band pass filter by input sensitivity switch S3a. If the switch is set to 5m V (30 V MAX.), the output signal of the IC1 is transferred to the band pass filter without modification (that is, IC2 gain = 1 (0 dB)).

If the switch is set to 0.5m V (100m V MAX.), the output signal of the IC1 is transferred to the band pass filter after being amplified ten times (that is, IC2 gain = 10 (+20 dB)).

The band pass filter is a kind of signal selector. This band pass filter is very important because input signals may contain power source humming noises and high-band noises. These signal noises might cause an error during wow/flutter measurement, and degrade the wow/flutter measurement accuracy. The filter only selects signals with a frequency of 3 kHz or 3.15 kHz from the input signals.

Q1 and Q2 are low-impedance emitter-follower transistor circuits needed to drive the above band pass filter circuit. Even input signals that can pass the BPF circuit are attenuated in the circuit because the band pass filter consists of coils (L) and capacitors (C). For this reason, another amplifier is needed to activate the Schmitt trigger circuit and the level monitor circuit. This amplifier is device IC3. This IC is also required to perform the same function when this product is selected as a frequency counter by the select switch S3b. Its gain is about 30 (or +30 dB).

The signal amplified by the IC3 is transferred to the level monitor circuit via the emitter-follower circuit (Q6).

The signal from the IC3 amplifier is rectified by diodes D13 and D14 and then input to the Q7-Q8 darlington circuit. Transistor Q8 is turned on and the RL2 relay circuit is also activated when the base voltage level of the Q7 transistor changes to 1.2 to 1.4 V (twice the VBE level) at the input voltage of 5 mVrms.

When the RL2 relay circuit becomes active, the level monitor/overflow LED placed between the collector of transistor Q9 and the GND is turned on. The RL4 relay circuit is also energized and the wow/flutter measurement circuit becomes active at the same time.

If the product is selected as a frequency counter by select switch S3b and the frequency of the input signal is higher than '9.999 kHz' when the gate time = 1 second, the frequency counter block outputs an overflow signal. This overflow signal is input to the base of transistor Q9. This transistor then works as an electronic switch, turning the level monitor/overflow LED ON/OFF.

If the gate time is set to '0.1 second' and the frequency of the input is higher than '55.00 kHz', the level monitor/overflow LED becomes inactive because that signal is not within the measurement range.

Note that the RL4 relay circuit is inactive if this product is in the frequency counter mode. As a result, the meter function does not work because the signal lines of the wow/flutter measurement circuit are logically grounded to the earth.

The signal amplified by the IC3 amplifier is also input to the Schmitt trigger circuit made up of Q3, Q4 and Q5. This signal is then converted into square waveform signals by that circuit. These square waveform signals are input to the frequency counter and the wow/flutter measurement circuit.

Note that if this product is used as the wow/flutter measurement unit, adjust the VR2 (variable resistor 2) so that a sqaurewave signal with a duty cycle of 50% (1/2) can be produced at TP1 (test point 1).

The Schmitt trigger circuit will be inactivated by diode D12 and resistor R38 if transistor Q8 of the level monitor circuit is not turned on and the RL2 relay circuit does not become active. This circuit design is required to prevent unpredictable operations of the circuit blocks in the next stage.

CIRCUIT DESCRIPTION

2. WOW/FLUTTER MEASUREMENT CIRCUIT

Wow/flutter measurement circuit

The output signal from the Schmitt trigger circuit is input to an one shot multivibrator (or mono-stable multivibrator IC4) as trigger pulse. It passes through a differentiation circuit consisting of capacitor C16 and resistor R47 after inversion by D16 into negative-polarity signal.
The trigger pulse width is determined by the following relationship between an input center frequency and passive devices.
Input center frequency = 3 kHz (JIS, NAB, and CCIR): VR4, R51, and C18
Input center frequency = 3.15kHz (DIN): VR5, R52, and C18
The output from the IC4 is converted into +-15V square-wave signals by transistors Q10, Q11, and Q12 and then input to the low-pass filter (IC5). However, the RL4 relay circuit becomes inactive if the input signal outside of the measurement range is detected or this product is selected as the frequency counter by select switch S3b. As a result, the meter function does not work because the signal blocks following the IC5 are electronically disconnected from the unit system.
The low-pass filter made of the IC5 is a three-order multiple-feedback butterworth filter. Its cut-off frequency is 300 Hz (-3 dB) and its attenuation factor is-18 dB/OCT. This filter attenuates the input signal if it is higher than 300 Hz.
If this product receives the signals from external circuits such as a tape recorder and the signals contain wows/flutter characteristics, wow/flutter frequencies can be reproduced in the range of DC and 300 Hz.
Variable resistor VR6 is provided for offset adjustment of the IC5.
Variable resistor VR4 is provided to adjust the TP8 direct output into '0V' if the input center frequency (single sine wave signal) is 3kHz (JIS, NAB, and CCIR).
Variable resistor VR5 is provided to adjust the TP8 direct output into '0 V' if the input center frequency (single sine wave signal) is 3.15 kHz (DIN).
The output from the IC5 is also transmitted to an external circuit. Its output voltage per frequency drift 1% is 1 Vdc at the output impedance of 600 ohm.
The wow/flutter signals reproduced by the IC5 (low pass filter) is input to the S1 attenuator unit (X75-1110-00). In this unit, the full scale adjustment for each range can be made with variable resistors VR301 to VR305.
The output from the attenuator unit is input to the low-pass filter (IC6). Harmonic components higher than 3 kHz can be completely eliminated in this pass filter. This low-pass filter is the same type as that of the IC5 low pass filter. Its cut-off frequency is 200 H.
The output from the IC6 low-pass filter is selectively input to one of the WTD, WOW, FLUTTER, and UNWTD filters by select switch S2 of the function unit (X69-1000-00). Variable resistors VR7, VR8 and VR9 are provided as level setting adjusters based on WTD.
The signal selected by select switch S2 is transferred to the IC7 buffer amplifier through its corresponding filter. Then, it is input to one of the four high-pass filters. These four high-pass filters correspond to the four standards (JIS, NAB, CCIR and DIN). Select switch S4 is provided on the indication unit (X69-1010-00) to select one of the four high pass filters. The output from the selected high-pass filter is then input to the meter amplifier made up of IC8 and IC9. Variable resistors VR11 to VR14 are used as level setting adjustments based on JIS (VR11).
The signal selected by select switch S4 is input to IC8 and IC9. If the range selected by S1 is 0.003% to 1%, that signal is amplified +26 dB. It is amplified +6 dB in the 3%-10% range.
Variable resistor VR15 is provided for IC9 offset adjustment.
The output from the IC9 is transmitted to an external circuit. Its output voltage per meter full scale is 3 Vrms at an output impedance of 600 ohm. The output is also input to the X69-1010-00 indication unit and then sent to the corresponding detector.

(1) JIS standard detector circuit
The signal from the X69-1010-00 indication unit is input to the IC10 absolute amplifier and then rectified at full-wave level. This rectified signal is then sent to the smoothing circuit consisting of R93, C44, R94, and C45 through the indication unit. The smoothing circuit converts the input signal into a DC signal. This DC signal is input to the indication unit again and then drives the meter. Note that the meter indicates the effective values.
Variable resistor VR16 can be used as a peak adjustment of the signal waveforms output from the IC10 absolute amplifier.
(2) NAB standard detector circuit
The signal from the X69-1010-00 indication unit is input to the IC10 absolute amplifier and then drives the meter through R306. Note that the meter indicates the average values.
(3) CCIR/DIN standard detector circuit
The signal from the X69-1010-00 indication unit is detected by the IC11 peak detector and then input to the indication unit. It then drives the meter. Note that the meter indicates peak values.
Variable resistors VR17, VR18 and VR19 can be used as time-constant adjustments in the following manner:
VR17: Time constant adjustment for plus charge
VR18: Time constant adjustment for minus charge
VR19: Time constant adjustment for discharging

Meter output circuit

The IC12 and IC13 are amplifiers which generate the DC output from the values indicated by the meter.
The meter signal value is indicated by the two outputs from both ends of the meter. The signal is input to the IC12 buffer amplifier and then transmitted to the IC13 differential amplifier (1/2). This differential amplifier has an unbalanced output circuit. The output from this unbalanced output circuit is then input to the IC13 (2/2) amplifier and amplified to a level where an its output of 1Vdc per meter full scale is possible. The output from the IC13 amplifier is transferred to an external circuit as the RECORDER OUT signal. Its output impedance is 600 ohm.
Variable resistors VR20, VR21 and VR22 are used as adjustments in the following manner:

VR20 and VR21: IC13 offset adjustment
VR22: Adjuster for 1 Vdc output

Power supply circuit

The AC 20 V voltage from the power transformer is rectified by diode D24 into DC ± 20 V. It is then regulated by the stabilizer circuit consisting of IC4, Q101 and Q102. This stabilizer circuit outputs DC ± 15 V. This DC voltage is added to amplifier units and some blocks of the counter unit. This circuit uses the + 5 V voltage from the counter unit as the reference voltage. Variable resistor VR23 is adjusted so that − 15 V can be generated.

3. FREQUENCY COUNTER CIRCUIT (COUNTER UNIT)

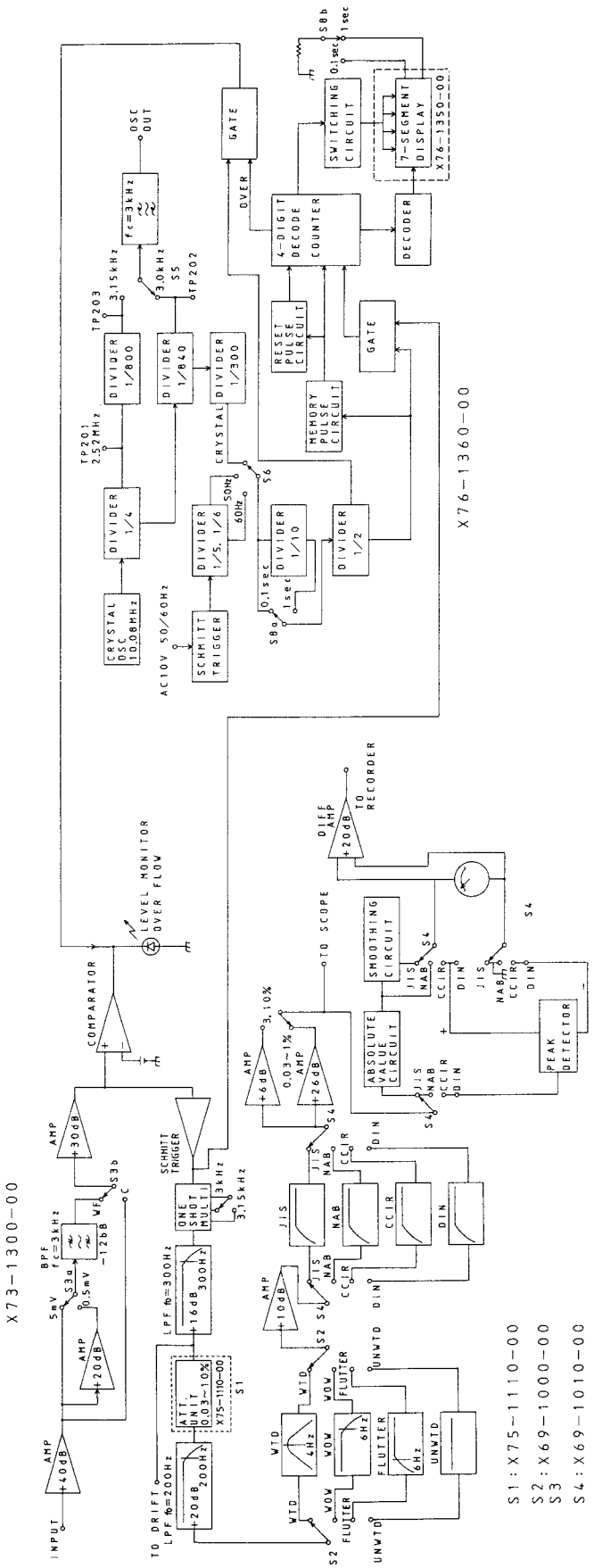
Frequency counter circuit

The frequency of the crystal oscillator employed in this unit is 10.080 MHz. The output from the crystal oscillator is first transmitted to transistor Q201 and then to the Q202 buffer transistor. It is then sent to the IC201 and divided by four into 2.5200 MHz. Use another frequency counter to measure the signal at test point TP201. If its frequency is not 2.5200 MHz, adjust TC201 so that it can reach 2.5200 MHz.
This signal (2.5200 MHz signal) is input to the divider circuit consisting of IC202, IC210 and IC211 and then divided by eight hundred into a 3.15 kHz-squarewave signal. It is also input to the divider circuit consisting of IC202 to IC206 and then divided by 840 into 3.00 kHz squarewave signal.
One of the squarewave signals described above is selected by the OSC select switch of the X69-1000-00 (S2) and then input to the IC212. It then moves onto a band pass filter through the low-impedance Q208 emitter follower output circuit. The band pass filter consists of three coils (L201 to L203) and four capacitors (C212 to C215).
The bandwidth of the filter is 3.0 ± 0.5 kHz (2.95 kHz to 3.5 kHz). Therefore, it can convert the squarewave signal with a frequency of 3 kHz or 3.15 kHz into sinewave signals with a distortion rate of less than 1.0%.
The sinewave signals are transferred to the Q209 buffer amplifier and then need to be adjusted by variable resistor VR201 into 200 mVrms output signals (with no load resistance). These output signals are transmitted to an external circuit as the OSC OUT signals. Their output impedance is 600 ohm.
The output from the IC206 (1/840 divider) is input to the 1/300 divider circuit consisting of IC207, IC208 and IC209 and then divided into a 10 Hz signal. This signal is used as a time base for the counter unit.
The 10 Vac output (50/60 Hz) from power transformer T1 is input to the 1/5 divider (IC214:50 Hz) or 1/6 divider (IC215:60 Hz) and then divided into a 10Hz signal. This signal is synchronized with the power supply signal (50/60 Hz).
One of the two 10-Hz signals described above that is generated based on the power supply signal(50/60 Hz) or crystal oscillation (10.08 MHz) is selected by select switch S6.
Select switch S8a is provided to select a gate time from 1 second and 0.1 second.
If the 1-second gate time is selected, the selected 10-Hz signal is transferred to the two divider circuits (IC216 and IC208) and then divided by 20 into a 1-second gate control signal.
If the 0.1-second gate time is selected, the selected 10-Hz signal is transferred to the 1/2 divider circuit directly and then converted into a 0.1-second gate control signal. These control signals are input to the pulse generation circuits (IC217 and IC218). The IC217 generates latch timing pulses from the control signals and then outputs them to the IC222 while the IC218 generates reset pulses from the signals and then outputs them to the IC222.
The output signal from the Schmitt trigger circuit of the amplifier unit is input to the IC224 gate circuit through the Q203 and IC224 buffer. It is then transmitted to the IC222 as a counter clock signal after it is mixed with the 1-second or 0.1-second gate control signal.
The IC222 is a 4-digit decode counter. Its B.C.D output is input to the IC221 and then decoded into 7-segment LED drive signals. These decoded signals are input to the cathode terminals of the 7-segment LEDs. The output from the IC222 decode counter is input to the anode terminals of the 7-segment LEDs through the switching circuit consisting of the IC223 and transistors Q204 to Q207.
The IC222 4-digit decode counter outputs an overflow signal if the gate time is set to 1 second and the signal higher than '9.999 kHz' is input. This overflow signal is transmitted to the IC216, IC220
and then IC219, and finally turns the level monitor LED ON and OFF.

Power supply circuit

The AC 10V output from power transformer T1 is rectified by diode D202 and then input to the stabilizer circuit consisting of IC225 and Q103. The stabilizer circuit regulates the D202 output and then generates + 5 V. This + 5 V voltage is added to each TTL circuit. It is also added to the stabilizer circuit of the amplifier unit and used as the reference voltage.

BLOCK DIAGRAM



ADJUSTMENT

To obtain the best performance, periodically calibrate the unit. Sometimes, only one mode need be calibrated, while at other times, all modes should be calibrated. When one mode is calibrated, it must be noted that the other modes may be affected. When calibrating all modes, perform the calibration in the specified sequence.
The following calibration required an accurate measuring instrument and an insulated adjusting flat blade screwdriver. If they are not available, contact your dealer. For optimum adjustment, turn the power on and warm up the scope sufficiently (more than 30 minutes) before starting.
Before calibrating the unit, check the power supply voltage.

TEST EQUIPMENT REQUIRED

The following instrument or their equivalent should be used for making adjustment.

Test Equipment	Model	Maker
Frequency Counter	FC-756	KENWOOD
Digital Multimeter	8600A	FLUKE
Sine-Wave Generator	651B	HP
SSVM	VT-106	KENWOOD
Wow-Flutter Calibrator	MWS-670C	MEGURO
Oscilloscope	CS-6010	KENWOOD
Distortion Meter	885	ShibaSoku
Watt-meter	DPB-1W	YEW
Insulation Meter	SM-5	TOA
Fuction Generator	FG-273	KENWOOD

PREPARATION FOR ADJUSTMENT

Control Settings

The control settings listed below must be used for each adjustment procedure.
Exceptions to these settings will be noted as they occur. After completing a adjustment, return the controls to the following settings.

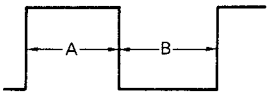
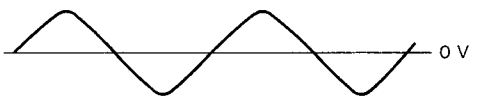
NAME OF KNOBS	POSITION
POWER	ON
OCS	3 kHz
MODE	WOW FLUTTER
LEVEL	5 mV ~ 30 V
REFERENCE FREQUENCY	CRYSTAL

ADJUSTMENT

1. POWER SUPPLY AND COUNTER SECTION ADJUSTMENTS

Item	Adjustment VR (TC)	P.C.B.	Procedure
− 15 V	VR23	X73-1300-00	Connect the DVM (VCD) to TP17, then, adjust − 15 V. − 15.00 V ± 1% (− 14.85 to − 15.15 V)
Frequency	TC201	X76-1110-00	Connect the F-counter to TP201, then, adjust the frequency. 2.52 MHz ± 5 Hz
Recording signal Output Level	VR201		Connect the SSVM to the OSC output, then, adjust the output voltage. 0.2 Vrms ± 20% (0.16 to 0.24 Vrms)

2. WOW-FLUTTER METER SECTION ADJUSTMENTS

Item	Adjustment VR (TC)	P.C.B.	Procedure
Zero point	—	—	Adjust so that the meter's pointer mechanically points out zero upon switching OFF the power supply.
Offset	VR6 VR15 VR21	X73-1300-00	1) Make the input short. a. Connect the DVM (DCV) to TP8, then, adjust VR6 to zero volt. b. Connect the DVM (DCV) to TP10, then, adjust VR15 to zero volt. 2) Make the meter short. Connect the DVM (DCV) to TP15, then, adjust VR21 to zero volt.
Threshold Level	VR2	X73-1300-00	Connect an oscilloscope to TP5. Adjust so that the duty of TP5's sine-wave (square wave) becomes 50% upon adding a 3 kHz sine-wave to the input.  A = B Note: Then the input voltage should be below 5 mVrms.
3 kHz Offset	VR4	X73-1300-00	1) Connect the oscilloscope to TP8 (DC, 50 mV/DIV), then, make the input short. Then, make sure that the TP8's voltage is zero. 2) When a 3 kHz sine-wave is added to the input via the OSC output, adjust so that the TP8's sine-wave oscillates areound zero volt as center, as shown below. 
3.15 kHz Offset	VR5	X73-1300-00	INDICATION: DIN 1) Connect the OSC to TP8 (DC, 50 mV/DIV), then, make the input short. Then, make sure that the TP8's voltage is zero. 2) When a 3.15 kHz sine-wave is added to the input via the OSC output, adjust so that the TP8's waveform becomes as shown in 3-7 (2).
Peak Value	VR16	X73-1300-00	CAL: 3 kHz, JIS, 50 Hz, 1% Set: JIS, UNWTD, 1% Connect the OSC to TP11 (AC, 5 V/DIV), then, adjust so that the wave heights are all aligned at a certain level.

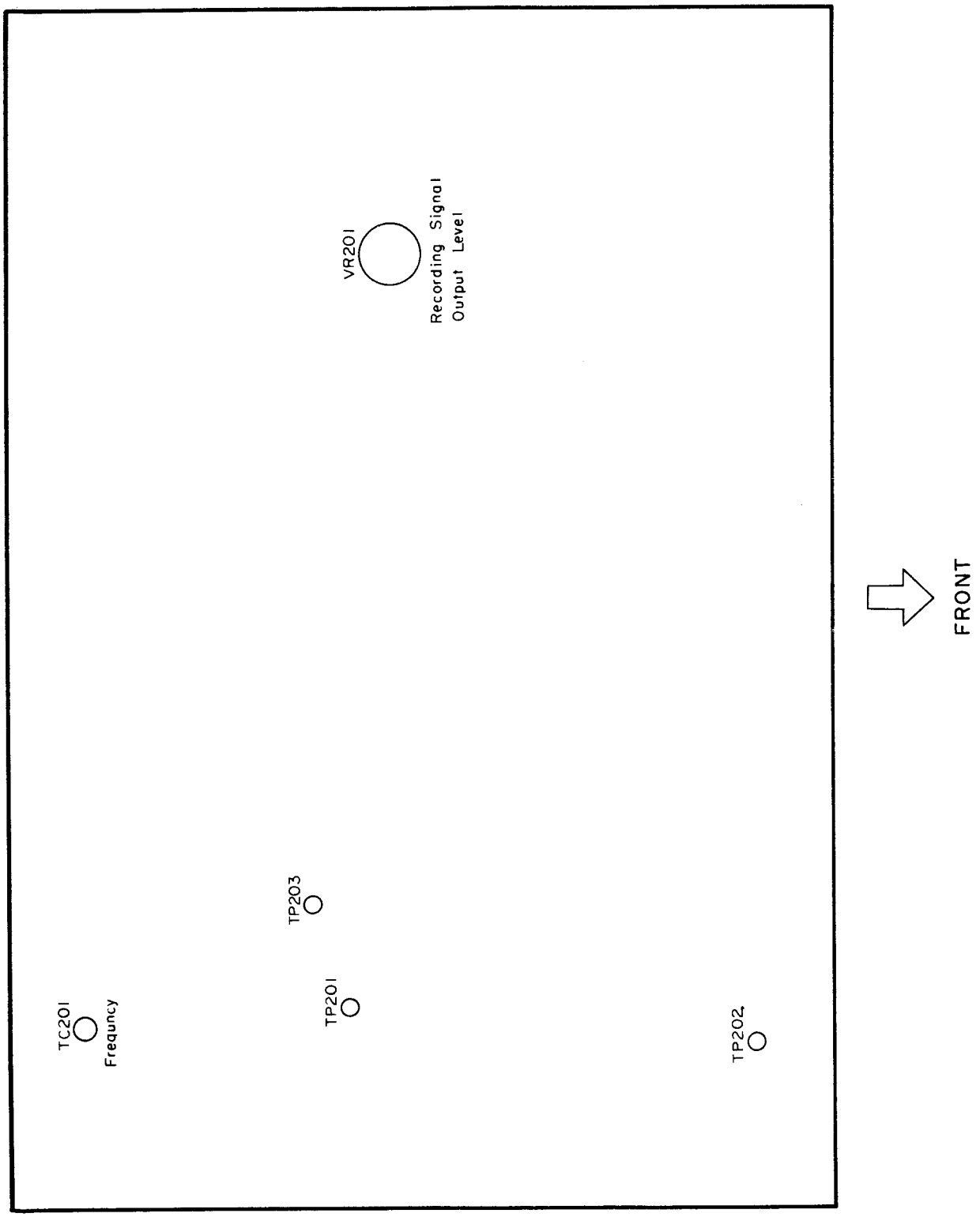
ADJUSTMENT

1. POWER SUPPLY AND COUNTER SECTION ADJUSTMENTS

<table>
<tr><th>Item</th><th>Adjustment VR (TC)</th><th>P.C.B.</th><th>Procedure</th></tr>
<tr><td>0.03% Fullscale</td><td>VR11</td><td>X73-1300-00</td><td>CAL: 3 kHz, JIS, 4 Hz, 0.03%
Set: JIS, WTD, 0.03%
Adjust VR11 so that the meter swings over the full scale.</td></tr>
<tr><td>Range Fullscale</td><td>VR301
VR302
VR303
VR304
VR305</td><td>X75-1110-00</td><td>CAL: 3 kHz, JIS, 4 Hz
Set: JIS, WTD
Adjust so that the meter swings over the full scale at each range.
<table><tr><th>CAL. WOW (%)</th><th>Setting range (%)</th><th>Adjusting VR.</th></tr><tr><td>0.10</td><td>0.1</td><td>VR301</td></tr><tr><td>0.30</td><td>0.3</td><td>VR302</td></tr><tr><td>1.00</td><td>1</td><td>VR303</td></tr><tr><td>3.00</td><td>3</td><td>VR304</td></tr><tr><td>3.99</td><td>10</td><td>VR305</td></tr></table>Note: Adjust the 10% range so that the meter swings by 3.99% (4.0%).</td></tr>
<tr><td>Wow Level</td><td>VR8</td><td>X73-1300-00</td><td>CAL: JIS, 3 kHz, 1.8 Hz, 1%
Set: JIS, WOW, 1%
Under this condition, adjust so that the meter swings over the full scale.</td></tr>
<tr><td>FLUTTER Level</td><td>VR9</td><td>X73-1300-00</td><td>CAL: JIS, 3 kHz, 40 Hz, 1%
Set: JIS, FLUTTER, 1%
Under this condition, adjust so that the meter swings over the full scale.</td></tr>
<tr><td>UNWTD Level</td><td>VR7</td><td>X73-1300-00</td><td>CAL: JIS, 3 kHz, 40 Hz, 1%
Set: NAB, UNWTD, 1%
Under this condition, adjust so that the meter swings over the full scale.</td></tr>
<tr><td>NAB Level</td><td>VR12</td><td>X73-1300-00</td><td>CAL: JIS, 3 kHz, 40 Hz, 1%
Set: NAB, UNWTD, 1%
Under this condition, adjust so that the meter swings over the full scale.</td></tr>
<tr><td>CCIR Level</td><td>VR13
VR19</td><td>X73-1300-00</td><td>CAL: CCIR, 3 kHz, 40 Hz, 1%
Set: CCIR, UNWTD, 1%
1) Connect the DVM (VAC) to TP10, then, adjust VR13 to 3.50 V.
2) Then, adjust VR19 so that the meter swings over the full scale.</td></tr>
<tr><td>DIN Level</td><td>VR14</td><td>X73-1300-00</td><td>CAL: CCIR, 3.15 kHz, 40 Hz, 1%
Set: DIN, UNWTD, 1%
Under this condition, adjust so that the meter swings over the full scale.</td></tr>
<tr><td>Recorder Out gain</td><td>VR22</td><td>X73-1300-00</td><td>CAL: JIS, 3 kHz, 40 Hz, 1%
Set: JIS, UNWTD, 1%
Under this condition (as swung over the full scale), adjust so that the recorder's output voltage becomes 1 VDC.</td></tr>
</table>

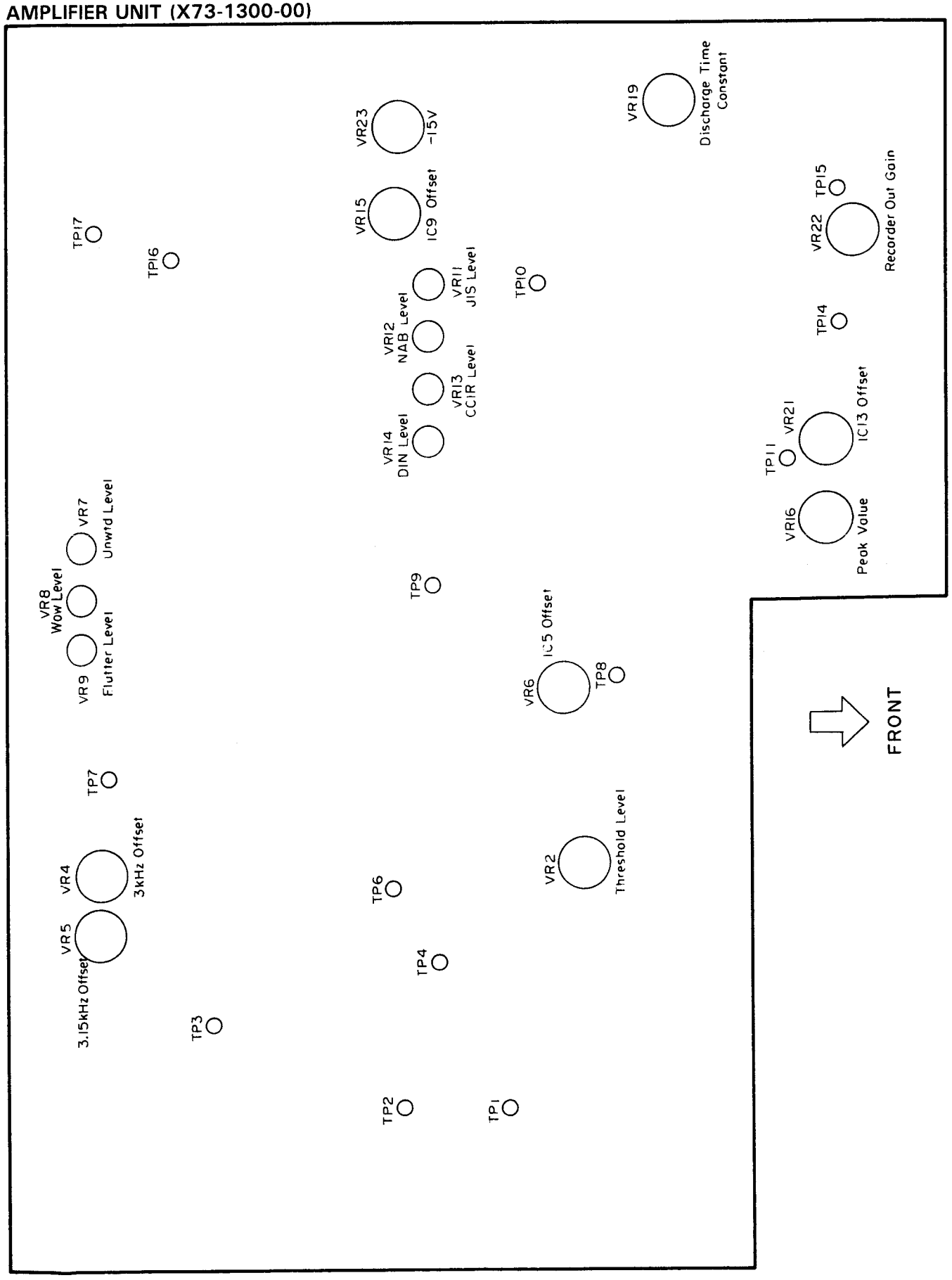
ADJUSTMENT

CONTROL UNIT (X76-1360-00)



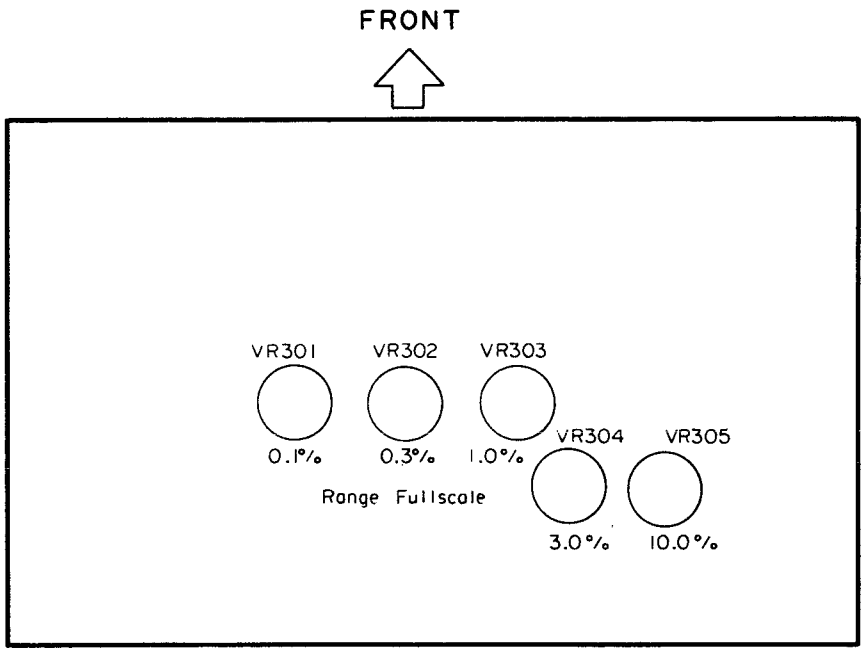
ADJUSTMENT

AMPLIFIER UNIT (X73-1300-00)



ADJUSTMENT

ATTENUATOR UNIT (X75-1110-00)



PARTS LIST

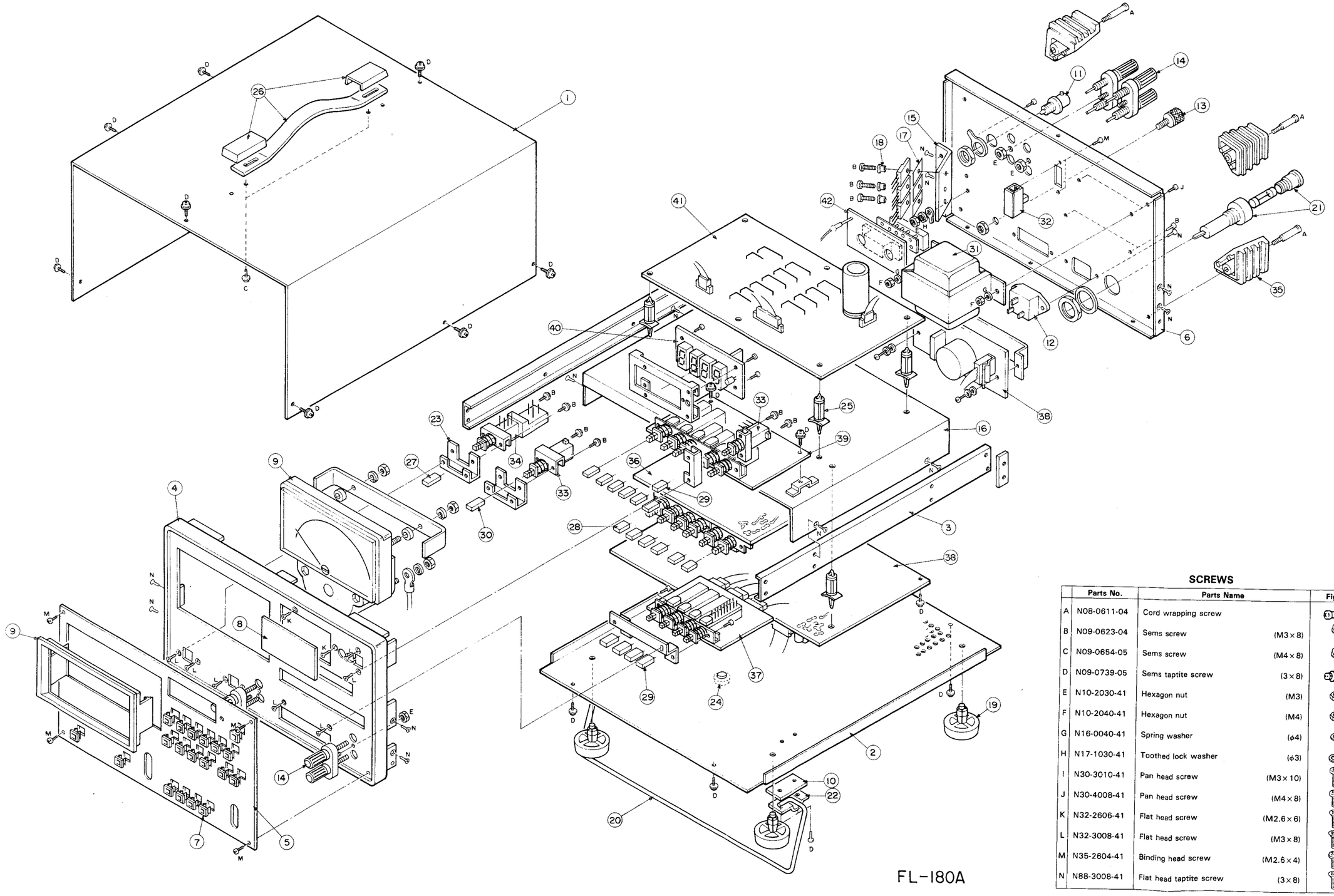
FL-180A UNIT

Y80-1340-00

REF.NO	PARTS NO	NAME & DESCRIPTION
	B42-1814-04	LABEL
	B50-7692-00	INSTRUCTION MANUAL,JAPANESE
	B50-7693-00	INSTRUCTION MANUAL,ENGLISH
	E30-1644-15	BS POWER CORD
	E30-1818-05	JIS POWER CORD
	E30-1819-05	CEE POWER CORD
	E30-1820-05	UL/CSA POWER CORD
	E30-1821-05	SAA POWER CORD
	E31-0694-05	WIRE ASS'Y(P1 TO INPUT)
	E31-0695-05	WIRE ASS'Y(P304 TO P2/P3)
	E31-0696-05	WIRE ASS'Y(P303 TO P7)
	E31-0697-05	WIRE ASS'Y(P302 TO P6)
	E31-0698-05	WIRE ASS'Y(P307 TO P8)
	E31-0699-05	WIRE ASS'Y(P305 TO P9)
	E31-0700-05	WIRE ASS'Y(P306 TO P10)
	E31-0702-05	WIRE ASS'Y(P301 TO P5/DRIFT)
	E31-0703-05	WIRE ASS'Y(P206 TO Q101)
	E31-0704-05	WIRE ASS'Y(P201 TO S5/S6)
	E31-0705-05	WIRE ASS'Y(P203 TO P16/OUT)
	E31-0706-05	WIRE ASS'Y(P15 TO Q102/Q103)
	E31-0707-05	WIRE ASS'Y(P11 TO SCOPE)
	E31-0708-05	WIRE ASS'Y(P13 TO RECORDER)
	E31-0709-05	WIRE ASS'Y(P12 TO METER)
	E31-0710-05	WIRE ASS'Y(P17 TO S6)
	E31-0711-05	WIRE ASS'Y(P19 TO POWER SW)
	E31-0716-05	WIRE ASS'Y(P18 TO AC INLET)
	E31-0717-15	WIRE ASS'Y(FOR GROUNDED EARTH)
	E31-0788-05	WIRE ASS'Y(P19 TO POWER SW)
	E31-0789-05	WIRE ASS'Y(V.SELECTOR TO FUSE)
	E31-5683-05	WIRE ASS'Y(P402 TO S8)
	E31-5684-05	WIRE ASS'Y(P202/204/401 TO P4)
	E31-5822-05	WIRE ASS'Y(P207 TO S8)
	F05-3011-05	FUSE(6X30MM) 0.3A
	F05-3112-05	FUSE(5X20MM) 0.3AT
	F05-5013-05	FUSE(6X30MM) 0.5A
	H01-5910-04	CARTON BOX
	H10-2813-02	FOAMED STYRENE PAD
	H20-1715-04	VINYL COVER
	J19-1620-05	CORD KEEP
	J61-0503-05	BOARD SUPPORT
	X67-1000-00	ACCESSORY CORD(CA-36)
Q101	2SA1111(R)	TR. SI. PNP
Q102	2SC2591(R)	TR. SI. NPN
Q103	2SA1111(R)	TR. SI. PNP
1	A01-1212-03	CASE(TOP)
2	A01-1213-03	CASE(BOTTOM)
3	A13-0943-03	FRAME
4	A20-2841-02	DIECAST PANEL
5	A21-1154-03	DECORATIVE PANEL
6	A23-1698-02	REAR PANEL
7	B07-0706-04	ESCUTCHEON (FOR PUSH SWITCH)
8	B19-0711-04	FILTER
9	B31-0738-05	METER
10	B39-0407-04	SPACER
11	E04-0259-05	BNC RECEPTACLE
12	E18-0351-05	AC INLET 3 P
13	E21-0667-05	METAL TERMINAL
14	E21-0669-03	PAIR TERMINAL
15	F01-0824-04	HEAT SINK
16	F10-1541-02	SHIELD PLATE
17	F20-0078-05	INSULATOR
18	F29-0014-05	INSULATOR
19	J02-0089-05	RUBBER FOOT
20	J02-0509-04	TILT STAND
21A	J13-0033-15	FUSE HOLDER
21B	J13-0031-05	FUSE HOLDER (NORTH EUROPE)
22	J21-2573-04	HOLDER FOR LEG
23	J21-2911-04	BLACKET FOR SW
24	J42-0510-04	BUSHING
25	J61-0049-05	WIRE BAND
26	K01-0410-05	HANDLE
27	K27-0506-04	BUTTON:ORANGE
28	K27-0549-04	BUTTON:WHITE
29	K27-0550-04	BUTTON:GRAY
30	K27-0551-04	BUTTON:BLUE
31	L01-9226-05	POWER TRANSFORMER
32	S31-2509-05	SLIDE SWITCH
33	S40-2511-05	PUSH SWITCH,POWER
34	S40-2510-05	PUSH SWITCH
35	W01-0503-04	REAR RUBBER FOOT/CORD WRAP

REF.NO	PARTS NO	NAME & DESCRIPTION
36	X69-1000-00	FUNCTION UNIT
37	X69-1010-00	SWITCH UNIT
38	X73-1300-00	AMPLIFIER UNIT
39	X75-1110-00	ATTENUATOR UNIT
40	X76-1350-00	INDICATION UNIT
41	X76-1360-00	COUNTER UNIT
42	X77-1020-00	VOLTAGE SELECTOR UNIT

DISASSEMBLY



FL-180A

SCREWS

	Parts No.	Parts Name		Figure
A	N08-0611-04	Cord wrapping screw		
B	N09-0623-04	Sems screw	(M3×8)	
C	N09-0654-05	Sems screw	(M4×8)	
D	N09-0739-05	Sems taptite screw	(3×8)	
E	N10-2030-41	Hexagon nut	(M3)	
F	N10-2040-41	Hexagon nut	(M4)	
G	N16-0040-41	Spring washer	(φ4)	
H	N17-1030-41	Toothed lock washer	(φ3)	
I	N30-3010-41	Pan head screw	(M3×10)	
J	N30-4008-41	Pan head screw	(M4×8)	
K	N32-2606-41	Flat head screw	(M2.6×6)	
L	N32-3008-41	Flat head screw	(M3×8)	
M	N35-2604-41	Binding head screw	(M2.6×4)	
N	N88-3008-41	Flat head taptite screw	(3×8)	

PARTS LIST

AMPLIFIER UNIT

X73-1300-00

REF.NO	PARTS NO	NAME & DESCRIPTION			
	E23-0563-05	TEST PIN			
	J21-2909-04	BRACKET FOR P.C.B.			
	J25-2877-12	PCB (UNMOUNTED)			
	N30-3006-41	SCREW. PAN HD	M3X6		
	R92-0150-05	JUMPING RES.	ZERO OHM(10MM)		
	SDT-1000	THERMISTOR			
C001	CQ93M2A104K	CAP. MYLAR	0.1	10%	100V
C002	CE04BW1E100M	CAP. ELECTRO	10	20%	25V
C003	CE04BW1E100M	CAP. ELECTRO	10	20%	25V
C004	CQ93BP2A333F	CAP. MYLAR	0.033	1%	100V
C005	CQ93BP2A274F	CAP. MYLAR	0.27	1%	100V
C006	CQ93BP2A274F	CAP. MYLAR	0.27	1%	100V
C007	CQ93BP2A333F	CAP. MYLAR	0.033	1%	100V
C008	CE04BW1E100M	CAP. ELECTRO	10	20%	25V
C009	CE04BW1E100M	CAP. ELECTRO	10	20%	25V
C010	CE04BW1E100M	CAP. ELECTRO	10	20%	25V
C011	CK45B1H331K	CAP. CERAMIC	330P	10%	50V
C012	CE04EW1C470M	CAP. ELECTRO	47	20%	16V
C013	CE04EW1C470M	CAP. ELECTRO	47	20%	16V
C014	CK45B1H102K	CAP. CERAMIC	1000P	10%	50V
C015	CE04EW1E101M	CAP. ELECTRO	100	20%	25V
C016	CK45B1H471K	CAP. CERAMIC	470P	10%	50V
C017	CK45B1H103K	CAP. CERAMIC	0.01	10%	50V
C018	CM93BF2A512F	CAP. MICA	5100P	1%	100V
C019	CK45B1H331K	CAP. CERAMIC	330P	10%	50V
C020	CQ93BP2A164F	CAP. MYLAR	0.16	1%	100V
C021	CQ93BP2A114F	CAP. MYLAR	0.11	1%	100V
C022	CQ93BP2A152F	CAP. MYLAR	1500P	1%	100V
C023	CE04BW1E221M	CAP. ELECTRO	220	20%	25V
C024	CQ93BP2A204F	CAP. MYLAR	0.2	1%	100V
C025	CQ93BP2A134F	CAP. MYLAR	0.13	1%	100V
C026	CQ93BP2A182F	CAP. MYLAR	1800P	1%	100V
C027	CQ93BP2A334F	CAP. MYLAR	0.33	1%	100V
C028	CF93AN2A684J	CAP. POLYESTHEL	0.68	5%	100V
C029	CQ93BP2A334F	CAP. MYLAR	0.33	1%	100V
C030	CQ93BP2A333F	CAP. MYLAR	0.033	1%	100V
C031	CQ93BP2A274F	CAP. MYLAR	0.27	1%	100V
C032	CQ93BP2A274F	CAP. MYLAR	0.27	1%	100V
C033	CQ93BP2A274F	CAP. MYLAR	0.27	1%	100V
C034	CQ93BP2A473F	CAP. MYLAR	0.047	1%	100V
C035	CQ93BP2A184F	CAP. MYLAR	0.18	1%	100V
C036	CQ93BP2A164F	CAP. MYLAR	0.16	1%	100V
C037	CQ93BP2A474F	CAP. MYLAR	0.47	1%	100V
C038	CF93AN2A684J	CAP. POLYESTHEL	0.68	5%	100V
C039	CQ93BP2A474F	CAP. MYLAR	0.47	1%	100V
C040	CF93AN2A684J	CAP. POLYESTHEL	0.68	5%	100V
C041	CK45B1H102K	CAP. CERAMIC	1000P	10%	50V
C042	CQ93M1H682K	CAP. MYLAR	6800P	10%	50V
C043	CE04BW1E101M	CAP. ELECTRO	100	20%	25V
C044	CE04EW1E101M	CAP. ELECTRO	100	20%	25V
C045	CE04EW1E101M	CAP. ELECTRO	100	20%	25V
C046	C90-0903-05	CAP. ELECTRO	33	20%	25V
C047	C90-0904-05	CAP. ELECTRO	47	20%	25V
C048	C90-0903-05	CAP. ELECTRO	33	20%	25V
C049	C90-0904-05	CAP. ELECTRO	47	20%	25V
C050	CE04EW1V222M	CAP. ELECTRO	2200	20%	35V
C051	CE04EW1H102M	CAP. ELECTRO	1000	20%	50V
C052	CE04EW1E221M	CAP. ELECTRO	220	20%	25V
C053	CE04EW1E221M	CAP. ELECTRO	220	20%	25V
C054	CE04EW1A101M	CAP. ELECTRO	100	20%	10V
C055	C90-0298-05	CAP. CERAMIC	0.1	20%	12V
C056	CE04EW1E101M	CAP. ELECTRO	100	20%	25V
C057	CE04EW1E101M	CAP. ELECTRO	100	20%	25V
C058	CE04EW1E101M	CAP. ELECTRO	100	20%	25V
C059	CE04EW1E101M	CAP. ELECTRO	100	20%	25V
C060	CE04EW1E101M	CAP. ELECTRO	100	20%	25V
C061	CE04EW1E101M	CAP. ELECTRO	100	20%	25V
C062	CE04EW1E101M	CAP. ELECTRO	100	20%	25V
C063	CE04EW1E101M	CAP. ELECTRO	100	20%	25V
C064	C91-0571-05	CAP. CERAMIC	0.01		2KV
C065	C91-0571-05	CAP. CERAMIC	0.01		2KV
C066	C91-0571-05	CAP. CERAMIC	0.01		2KV
D001	1SS132	DIODE			
D002	MTZ6.2JB	DIODE, ZENER	6.1V		
D003	1SS132	DIODE			
D004	MTZ6.2JB	DIODE, ZENER	6.1V		
D005	1S1555	DIODE			
D006	1S1555	DIODE			
D007	1S1555	DIODE			
D008	1S1555	DIODE			
D009	1S1555	DIODE			
D010	1S1555	DIODE			
D011	1S1555	DIODE			
D012	1S1555	DIODE			
D013	1S1555	DIODE			
D014	1N60	DIODE			
D015	1S1555	DIODE			
D016	1S1555	DIODE			
D017	1S1555	DIODE			
D018	1S1555	DIODE			
D019	1S1555	DIODE			
D020	1S1555	DIODE			
D021	1S1555	DIODE			
D022	1S1555	DIODE			
D023	1S1555	DIODE			
D024	S1VB60	DIODE			
D025	MTZ16JA	DIODE, ZENER	15V		
D026	MTZ10JC	DIODE, ZENER	9.95V		
D027	MTZ16JA	DIODE, ZENER	15V		
D028	MTZ10JC	DIODE, ZENER	9.95V		
D029	1S1555	DIODE			
IC001	CA3140E	IC. OP AMP			
IC002	LM741CN	IC. MONOLITHIC JFET INPUT OP			
IC003	NJM4558D	IC. DUAL OP AMP			
IC004	NJM555D	IC. TIMER			
IC005	LM741CN	IC. MONOLITHIC JFET INPUT OP			
IC006	NJM4558D	IC. DUAL OP AMP			
IC007	CA3140E	IC. OP AMP			
IC008	CA3140E	IC. OP AMP			
IC009	LM741CN	IC. MONOLITHIC JFET INPUT OP			
IC010	NJM4558D	IC. DUAL OP AMP			
IC011	NJM4558D	IC. DUAL OP AMP			
IC012	NJM4558D	IC. DUAL OP AMP			
IC013	NJM4558D	IC. DUAL OP AMP			
IC014	NJM4558D	IC. DUAL OP AMP			
L001	L40-1045-21	FERRI INDUCTOR	100MH		
L002	L40-4725-29	FERRI INDUCTOR	4.7MH		
L003	L40-1045-21	FERRI INDUCTOR	100MH		
L004	L33-0808-05	CHOKE COIL			
P001	E40-0473-05	PIN CONNECTOR	4P		
P002	E40-0473-05	PIN CONNECTOR	4P		
P003	E40-0973-05	PIN CONNECTOR	9P		
P004	E40-0673-05	PIN CONNECTOR	6P		
P005	E40-0973-05	PIN CONNECTOR	9P		
P006	E40-1413-05	PIN CONNECTOR	14P		
P007	E40-1513-05	PIN CONNECTOR	15P		
P008	E40-0973-05	PIN CONNECTOR	9P		
P009	E40-0773-05	PIN CONNECTOR	7P		
P010	E40-1073-05	PIN CONNECTOR	10P		
P011	E40-0473-05	PIN CONNECTOR	4P		
P012	E40-0473-05	PIN CONNECTOR	4P		
P013	E40-0473-05	PIN CONNECTOR	4P		
P014	E40-0573-05	PIN CONNECTOR	5P		
P015	E40-0973-05	PIN CONNECTOR	9P		
P016	E40-0773-05	PIN CONNECTOR	7P		
P017	E40-0473-05	PIN CONNECTOR	4P		
P018	E40-0430-05	PIN CONNECTOR	4P		
P019	E40-0430-05	PIN CONNECTOR	4P		
Q001	2SC945(P)	TR. SI. NPN			
Q002	2SA733(P)	TR. SI. PNP			
Q003	2SC945(P)	TR. SI. NPN			
Q004	2SC945(P)	TR. SI. NPN			
Q005	2SA733(P)	TR. SI. PNP			
Q006	2SC945(P)	TR. SI. NPN			
Q007	2SC945(P)	TR. SI. NPN			
Q008	2SC945(P)	TR. SI. NPN			
Q009	2SC945(P)	TR. SI. NPN			
Q010	2SA733(P)	TR. SI. PNP			
Q011	2SC945(P)	TR. SI. NPN			
Q012	2SA733(P)	TR. SI. PNP			
R001	RN14BK2E3003F	RES. METAL FILM	300K	1%	1/4W
R002	RD14BY2H473J	RES. CARBON	47K	5%	1/2W
R003	RD14BB2E102J	RES. CARBON	1K	5%	1/4W
R004	RD14BB2E104J	RES. CARBON	100K	5%	1/4W
R005	RD14BB2E123J	RES. CARBON	12K	5%	1/4W
R006	RD14BB2E472J	RES. CARBON	4.7K	5%	1/4W
R007	RN14BK2E5101F	RES. METAL FILM	5.1K	1%	1/4W

PARTS LIST

REF.NO	PARTS NO	NAME & DESCRIPTION			
R008	RD14BB2E473J	RES. CARBON	47K	5%	1/4W
R009	RD14BB2E392J	RES. CARBON	3.9K	5%	1/4W
R010	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R011	RD14BB2E222J	RES. CARBON	2.2K	5%	1/4W
R012	RD14BB2E222J	RES. CARBON	2.2K	5%	1/4W
R013	RD14BB2E100J	RES. CARBON	10	5%	1/4W
R014	RD14BB2E100J	RES. CARBON	10	5%	1/4W
R015	RD14BB2E390J	RES. CARBON	39	5%	1/4W
R016	RD14BB2E390J	RES. CARBON	39	5%	1/4W
R017	RD14BB2E561J	RES. CARBON	560	5%	1/4W
R018	RN14BK2E9100F	RES. METAL FILM	910	1%	1/4W
R019	RD14BB2E123J	RES. CARBON	12K	5%	1/4W
R020	RD14BB2E104J	RES. CARBON	100K	5%	1/4W
R021	RD14BB2E123J	RES. CARBON	12K	5%	1/4W
R022	RD14BB2E273J	RES. CARBON	27K	5%	1/4W
R023	RD14BB2E103J	RES. CARBON	10K	5%	1/4W
R024	RD14BB2E104J	RES. CARBON	100K	5%	1/4W
R025	RD14BB2E103J	RES. CARBON	10K	5%	1/4W
R026	RD14BB2E154J	RES. CARBON	150K	5%	1/4W
R027	RD14BB2E472J	RES. CARBON	4.7K	5%	1/4W
R028	RN14BK2E1502F	RES. METAL FILM	15K	1%	1/4W
R029	RN14BK2E2201F	RES. METAL FILM	2.2K	1%	1/4W
R030	RD14BB2E562J	RES. CARBON	5.6K	5%	1/4W
R031	RD14BB2E472J	RES. CARBON	4.7K	5%	1/4W
R032	RD14BB2E153J	RES. CARBON	15K	5%	1/4W
R033	RD14BB2E103J	RES. CARBON	10K	5%	1/4W
R034	RD14BB2E332J	RES. CARBON	3.3K	5%	1/4W
R035	RD14BB2E103J	RES. CARBON	10K	5%	1/4W
R036	RD14BB2E222J	RES. CARBON	2.2K	5%	1/4W
R037	RD14BB2E102J	RES. CARBON	1K	5%	1/4W
R038	RD14BB2E472J	RES. CARBON	4.7K	5%	1/4W
R039	RD14BB2E123J	RES. CARBON	12K	5%	1/4W
R040	RD14BB2E683J	RES. CARBON	68K	5%	1/4W
R041	RD14BB2E104J	RES. CARBON	100K	5%	1/4W
R042	RD14BB2E102J	RES. CARBON	1K	5%	1/4W
R043	RD14BB2E333J	RES. CARBON	33K	5%	1/4W
R044	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R045	RD14BB2E681J	RES. CARBON	680	5%	1/4W
R046	RD14BB2E103J	RES. CARBON	10K	5%	1/4W
R047	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R048	RN14BK2E6801F	RES. METAL FILM	6.8K	1%	1/4W
R049	RN14BK2E5601F	RES. METAL FILM	5.6K	1%	1/4W
R050	RD14BB2E332J	RES. CARBON	3.3K	5%	1/4W
R051	RN14BK2E3302F	RES. METAL FILM	33K	1%	1/4W
R052	RN14BK2E3002F	RES. METAL FILM	30K	1%	1/4W
R053	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R054	RD14BB2E103J	RES. CARBON	10K	5%	1/4W
R055	RD14BB2E472J	RES. CARBON	4.7K	5%	1/4W
R056	RD14BB2E332J	RES. CARBON	3.3K	5%	1/4W
R057	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R058	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R059	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R060	RN14BK2E3302F	RES. METAL FILM	33K	1%	1/4W
R061	RN14BK2E1003F	RES. METAL FILM	100K	1%	1/4W
R062	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R063	RD14BB2E273J	RES. CARBON	27K	5%	1/4W
R064	RN14BK2E6200F	RES. METAL FILM	620	1%	1/4W
R065	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R066	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R067	RD14BB2E472J	RES. CARBON	4.7K	5%	1/4W
R068	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R069	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R070	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R071	RD14BB2E273J	RES. CARBON	27K	5%	1/4W
R072	RN14BK2E6802F	RES. METAL FILM	68K	1%	1/4W
R073	RN14BK2E1001F	RES. METAL FILM	1K	1%	1/4W
R074	RN14BK2E1003F	RES. METAL FILM	100K	1%	1/4W
R075	RN14BK2E1003F	RES. METAL FILM	100K	1%	1/4W
R076	RN14BK2E1003F	RES. METAL FILM	100K	1%	1/4W
R077	RN14BK2E1203F	RES. METAL FILM	120K	1%	1/4W
R078	RD14BB2E105J	RES. CARBON	1M	5%	1/4W
R079	RD14BB2E153J	RES. CARBON	15K	5%	1/4W
R080	RD14BB2E432J	RES. CARBON	4.3K	5%	1/4W
R081	RN14BK2E8203F	RES. METAL FILM	820K	1%	1/4W
R082	RN14BK2E8203F	RES. METAL FILM	820K	1%	1/4W
R083	RN14BK2E8203F	RES. METAL FILM	820K	1%	1/4W
R084	RN14BK2E8203F	RES. METAL FILM	820K	1%	1/4W
R085	RD14BB2E105J	RES. CARBON	1M	5%	1/4W
R086	RD14BB2E102J	RES. CARBON	1K	5%	1/4W
R087	RD14BB2E222J	RES. CARBON	2.2K	5%	1/4W
R088	RD14BB2E223J	RES. CARBON	22K	5%	1/4W
R089	RD14BB2E103J	RES. CARBON	10K	5%	1/4W
R090	RD14BB2E562J	RES. CARBON	5.6K	5%	1/4W
R091	RD14BB2E103J	RES. CARBON	10K	5%	1/4W
R092	RN14BK2E6200F	RES. METAL FILM	620	1%	1/4W
R093	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R094	RN14BK2E2002F	RES. METAL FILM	20K	1%	1/4W
R095	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R096	RN14BK2E1802F	RES. METAL FILM	18K	1%	1/4W
R097	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R098	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R099	RN14BK2E2002F	RES. METAL FILM	20K	1%	1/4W
R100	RD14BB2E472J	RES. CARBON	4.7K	5%	1/4W
R101	RD14BB2E472J	RES. CARBON	4.7K	5%	1/4W
R102	RD14BB2E151J	RES. CARBON	150	5%	1/4W
R103	RD14BB2E472J	RES. CARBON	4.7K	5%	1/4W
R104	RD14BB2E472J	RES. CARBON	4.7K	5%	1/4W
R105	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R106	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R107	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R108	RN14BK2E1002F	RES. METAL FILM	10K	1%	1/4W
R111	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R112	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R113	RN14BK2E1601F	RES. METAL FILM	1.6K	1%	1/4W
R114	RN14BK2E6200F	RES. METAL FILM	620	1%	1/4W
R115	RD14BB2E561J	RES. CARBON	560	5%	1/4W
R116	RD14BB2E561J	RES. CARBON	560	5%	1/4W
R117	RN14BK2E1502F	RES. METAL FILM	15K	1%	1/4W
R118	RN14BK2E1502F	RES. METAL FILM	15K	1%	1/4W
R119	RN14BK2E1502F	RES. METAL FILM	15K	1%	1/4W
R120	RN14BK2E2003F	RES. METAL FILM	200K	1%	1/4W
R121	RD14BB2E104J	RES. CARBON	100K	5%	1/4W
R122	RN14BK2E4701F	RES. METAL FILM	4.7K	1%	1/4W
R123	RN14BK2E7502F	RES. METAL FILM	75K	1%	1/4W
R124	RD14BB2E224J	RES. CARBON	220K	5%	1/4W
R125	RD14BB2E334J	RES. CARBON	330K	5%	1/4W
R126	RN14BK2E7502F	RES. METAL FILM	75K	1%	1/4W
R127	RN14BK2E7502F	RES. METAL FILM	75K	1%	1/4W
R128	RN14BK2E4303F	RES. METAL FILM	430K	1%	1/4W
R129	RN14BK2E7503F	RES. METAL FILM	750K	1%	1/4W
R130	RN14BK2E1003F	RES. METAL FILM	100K	1%	1/4W
R131	RN14BK2E9103F	RES. METAL FILM	910K	1%	1/4W
R132	RN14BK2E4303F	RES. METAL FILM	430K	1%	1/4W
R133	RN14BK2E7503F	RES. METAL FILM	750K	1%	1/4W
R134	RN14BK2E4702F	RES. METAL FILM	47K	1%	1/4W
R135	RN14BK2E3902F	RES. METAL FILM	39K	1%	1/4W
R136	RD14BB2E181J	RES. CARBON	180	5%	1/4W
R137	RD14BB2E562J	RES. CARBON	5.6K	5%	1/4W
R138	RD14BB2C222J	RES. CARBON	2.2K	5%	1/6W
R139	NO USE				
R140	RD14BB2C222J	RES. CARBON	2.2K	5%	1/6W
R141	RD14BB2C334J	RES. CARBON	330K	5%	1/6W
RL001	SS1-1404-05	RELAY			
RL002	SS1-1404-05	RELAY			
RL003	SS1-1404-05	RELAY			
RL004	SS1-1404-05	RELAY			
RL005	SS1-1404-05	RELAY			
VR002	R12-3040-05	RES. SEMI FIXED	22K B		
VR003	NO USE				
VR004	R12-1501-05	RES. SEMI FIXED	1.5KB		
VR005	R12-1501-05	RES. SEMI FIXED	1.5KB		
VR006	R12-3041-05	RES. SEMI FIXED	10KB		
VR007	R12-5505-05	RES. SEMI FIXED	200K B		
VR008	R12-5505-05	RES. SEMI FIXED	200K B		
VR009	R12-5505-05	RES. SEMI FIXED	200K B		
VR010	NO USE				
VR011	R12-5508-05	RES. SEMI FIXED	200K B		
VR012	R12-5508-05	RES. SEMI FIXED	200K B		
VR013	R12-5508-05	RES. SEMI FIXED	200K B		
VR014	R12-5508-05	RES. SEMI FIXED	200K B		
VR015	R12-3041-05	RES. SEMI FIXED	10KB		
VR016	R12-1028-05	RES. SEMI FIXED	4.7KB		
VR019	R12-5026-05	RES. SEMI FIXED	220KB		
VR020	NO USE				
VR021	R12-3042-05	RES. SEMI FIXED	47KB		
VR022	R12-1501-05	RES. SEMI FIXED	1.5KB		
VR023	R12-0058-05	RES. SEMI FIXED	470 B		

PARTS LIST

ATTENUATOR UNIT

X75-1110-00

REF.NO	PARTS NO	NAME & DESCRIPTION			
	J25-2880-04	PCB (UNMOUNTED)			
P301	E40-0773-05	PIN CONNECTOR 7P			
R301	RN14BK2E4701F	RES. METAL FILM	4.7K	1%	1/4W
R302	RN14BK2E1502F	RES. METAL FILM	15K	1%	1/4W
R303	RN14BK2E2002F	RES. METAL FILM	20K	1%	1/4W
R304	RN14BK2E1502F	RES. METAL FILM	15K	1%	1/4W
R305	RN14BK2E2002F	RES. METAL FILM	20K	1%	1/4W
S001	S42-6502-05	PUSH SWITCH			
VR301	R12-3507-05	RES. SEMI FIXED	15KB		
VR302	R12-1028-05	RES. SEMI FIXED	4.7KB		
VR303	R12-1029-05	RES. SEMI FIXED	1K B		
VR304	R12-1028-05	RES. SEMI FIXED	4.7KB		
VR305	R12-1029-05	RES. SEMI FIXED	1K B		

COUNTER UNIT

X76-1360-00

REF.NO	PARTS NO	NAME & DESCRIPTION			
	E23-0563-05	TEST PIN			
	J25-5363-03	PCB (UNMOUNTED)			
C201	CC45CH1H220J	CAP. CERAMIC	22P	5%	50V
C202	CK45B1H331K	CAP. CERAMIC	330P	10%	50V
C203	CK45B1H331K	CAP. CERAMIC	330P	10%	50V
C204	CK45E1H102P	CAP. CERAMIC	1000P		50V
C205	CQ92M1H104K	CAP. MYLAR	0.1	10%	50V
C206	CE04EW1A101M	CAP. ELECTRO	100	20%	10V
C207	CE04EW1H3R3M	CAP. ELECTRO	3.3	20%	50V
C208	CQ92M1H104K	CAP. MYLAR	0.1	10%	50V
C209	CQ92M1H104K	CAP. MYLAR	0.1	10%	50V
C210	CQ92M1H104K	CAP. MYLAR	0.1	10%	50V
C211	CE04EW1E100M	CAP. ELECTRO	10	20%	25V
C212	CQ93BP2A333F	CAP. MYLAR	0.033	1%	100V
C213	CQ93BP2A274F	CAP. MYLAR	0.27	1%	100V
C214	CQ93BP2A274F	CAP. MYLAR	0.27	1%	100V
C215	CQ93BP2A333F	CAP. MYLAR	0.033	1%	100V
C216	CE04EW1E100M	CAP. ELECTRO	10	20%	25V
C217	CE04EW1E100M	CAP. ELECTRO	10	20%	25V
C218	CE04EW1C472M	CAP. ELECTRO	4700	20%	16V
C219	CQ92M1H104K	CAP. MYLAR	0.1	10%	50V
C220	CE04EW1A221M	CAP. ELECTRO	220	20%	10V
C221	CQ92M1H104K	CAP. MYLAR	0.1	10%	50V
C222	CE04EW1A101M	CAP. ELECTRO	100	20%	10V
C223	CE04EW1A101M	CAP. ELECTRO	100	20%	10V
C224	CE04EW1E101M	CAP. ELECTRO	100	20%	25V
D201	MTZ6.2JB	DIODE, ZENER	6.1V		
D202	S1RBA40	DIODE			
D203	1SS132	DIODE			
IC201	SN74LS112AN	IC, DUAL JK-FF			
IC202	SN74LS93N	IC, 4-BIT BINARY COUNTER			
IC203	SN74LS00N	IC, QUAD 2-INPUT NAND GATE			
IC204	SN74LS90N	IC, DECADE COUNTER			
IC205	SN74LS90N	IC, DECADE COUNTER			
IC206	SN74LS90N	IC, DECADE COUNTER			
IC207	SN74LS92N	IC, DIVIDE-BY-TWELVE COUNTERS			
IC208	SN74LS90N	IC, DECADE COUNTER			
IC209	SN74LS90N	IC, DECADE COUNTER			
IC210	SN74LS90N	IC, DECADE COUNTER			
IC211	SN74LS90N	IC, DECADE COUNTER			
IC212	SN74LS00N	IC, QUAD 2-INPUT NAND GATE			
IC213	SN74LS132N	IC, QUAD 2-INPUT NAND SCHMITT			
IC214	SN74LS90N	IC, DECADE COUNTER			
IC215	SN74LS92N	IC, DIVIDE-BY-TWELVE COUNTERS			
IC216	SN74LS90N	IC, DECADE COUNTER			
IC217	SN74LS00N	IC, QUAD 2-INPUT NAND GATE			
IC218	SN74LS04N	IC,HEX INVERTER			
IC219	SN74LS74AN	IC, D-FLIP FLOP			
IC220	SN74LS00N	IC, QUAD 2-INPUT NAND GATE			
IC221	SN74LS47N	IC, DECODER/DRIVER			
IC222	MSM5502RS	IC, 4-DIGIT BCD DECADE COUNTER			
IC223	SN74LS00N	IC, QUAD 2-INPUT NAND GATE			
IC224	SN74LS00N	IC, QUAD 2-INPUT NAND GATE			
IC225	NJM78L05A	IC, POSITIVE VOLTAGE REGULATOR			

REF.NO	PARTS NO	NAME & DESCRIPTION			
L201	L40-1045-21	FERRI INDUCTOR	100MH		
L202	L40-4725-29	FERRI INDUCTOR	4.7MH		
L203	L40-1045-21	FERRI INDUCTOR	100MH		
L204	L40-1025-04	FERRI INDUCTOR	1.0MH		
P201	E40-0873-05	PIN CONNECTOR	8P		
P202	E40-0573-05	PIN CONNECTOR	5P		
P203	E40-0573-05	PIN CONNECTOR	5P		
P204	E40-1173-05	PIN CONNECTOR	11P		
P205	E40-0573-05	PIN CONNECTOR	5P		
P206	E40-0473-05	PIN CONNECTOR	4P		
P207	E40-0473-05	PIN CONNECTOR	4P		
Q201	2SC945(P)	TR. SI. NPN			
Q202	2SC945(P)	TR. SI. NPN			
Q203	2SC945(P)	TR. SI. NPN			
Q204	2SA733(P)	TR. SI. PNP			
Q205	2SA733(P)	TR. SI. PNP			
Q206	2SA733(P)	TR. SI. PNP			
Q207	2SA733(P)	TR. SI. PNP			
Q208	2SC945(P)	TR. SI. NPN			
Q209	2SC945(P)	TR. SI. NPN			
R201	RD14BB2E333J	RES. CARBON	33K	5%	1/4W
R202	RD14BB2E223J	RES. CARBON	22K	5%	1/4W
R203	RD14BB2E561J	RES. CARBON	560	5%	1/4W
R204	RD14BB2E561J	RES. CARBON	560	5%	1/4W
R205	RD14BB2E224J	RES. CARBON	220K	5%	1/4W
R206	RD14BB2E681J	RES. CARBON	680	5%	1/4W
R207	RD14BB2E561J	RES. CARBON	560	5%	1/4W
R208	RD14BB2E561J	RES. CARBON	560	5%	1/4W
R209	RD14BB2E681J	RES. CARBON	680	5%	1/4W
R210	RD14BB2E472J	RES. CARBON	4.7K	5%	1/4W
R211	RD14BB2E103J	RES. CARBON	10K	5%	1/4W
R212	RD14BB2E332J	RES. CARBON	3.3K	5%	1/4W
R213	RD14BB2E471J	RES. CARBON	470	5%	1/4W
R214	RD14BB2E471J	RES. CARBON	470	5%	1/4W
R215	RD14BB2E471J	RES. CARBON	470	5%	1/4W
R216	RD14BB2E222J	RES. CARBON	2.2K	5%	1/4W
R217	RD14BB2E222J	RES. CARBON	2.2K	5%	1/4W
R218	RD14BB2E222J	RES. CARBON	2.2K	5%	1/4W
R219	RD14BB2E222J	RES. CARBON	2.2K	5%	1/4W
R220	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R221	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R222	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R223	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R224	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R225	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R226	RD14BB2E101J	RES. CARBON	100	5%	1/4W
R227	RD14BB2E683J	RES. CARBON	68K	5%	1/4W
R228	RD14BB2E104J	RES. CARBON	100K	5%	1/4W
R229	RD14BB2E102J	RES. CARBON	1K	5%	1/4W
R230	RD14BB2E102J	RES. CARBON	1K	5%	1/4W
R231	RD14BB2E102J	RES. CARBON	1K	5%	1/4W
R232	RN14BK2E1501F	RES. METAL FILM	1.5K	1%	1/4W
R233	RD14BB2E683J	RES. CARBON	68K	5%	1/4W
R234	RD14BB2E104J	RES. CARBON	100K	5%	1/4W
R235	RD14BB2E102J	RES. CARBON	1K	5%	1/4W
R236	RN14BK2C6200F	RES. METAL FILM	620	1%	1/6W
R237	RD14BB2E680J	RES. CARBON	68	5%	1/4W
R238	RD14BB2C183J	RES. CARBON	18K	5%	1/6W
R239	RD14BB2C101J	RES. CARBON	100	5%	1/6W
TC201	C05-0303-05	CAP. TRIMMER	20PF		
VR201	R12-1543-05	RES. SEMI FIXED	1KB		
X201	L77-1004-05	• CRYSTAL RESONATOR			

PARTS LIST

INDICATION UNIT

X76-1350-00

REF.NO	PARTS NO	NAME & DESCRIPTION
	J21-4659-04	BRACKET.FOR P.C.BOARD
	J25-5362-04	PCB (UNMOUNTED)
	N30-2606-41	SCREW, PAN HD M 2.6X6
D401	B30-0916-05	LAMP
D402	LN514RA	DIODE
D403	LN514RA	DIODE
D404	LN514RA	DIODE
D405	LN514RA	DIODE
P401	E40-1373-05	PIN CONNECTOR 13P
P402	E40-0273-05	PIN CONNECTOR 2P

FUNCTION UNIT

X69-1000-00

REF.NO	PARTS NO	NAME & DESCRIPTION
	J25-2879-04	PCB (UNMOUNTED)
P302	E40-1273-05	PIN CONNECTOR 12P
P303	E40-1173-05	PIN CONNECTOR 11P
P304	E40-1073-05	PIN CONNECTOR 10P
S002	S42-4503-05	PUSH SWITCH
S003	S42-2507-05	PUSH SWITCH

SWITCH UNIT

X69-1010-00

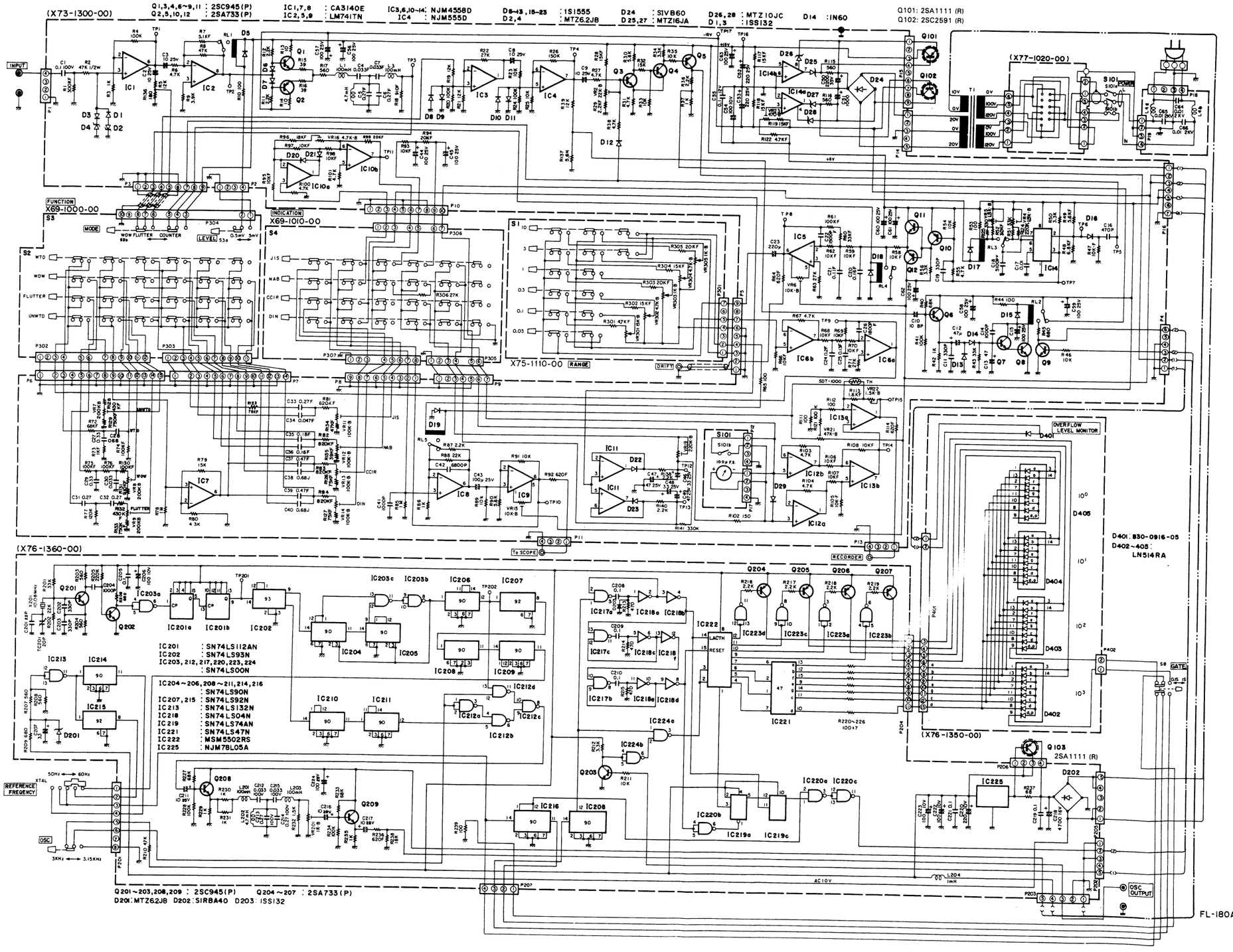
REF.NO	PARTS NO	NAME & DESCRIPTION
	J21-2910-04	BRACKET FOR SWITCH
	J25-2881-04	PCB (UNMOUNTED)
	N30-3006-41	SCREW, PAN HD M3X6
P305	E40-0674-05	PIN CONNECTOR 6P
P306	E40-0774-05	PIN CONNECTOR 7 P
P307	E40-0874-05	PIN CONNECTOR 8P
R306	RN14BK2E2702F	RES. METAL FILM 27K 1% 1/4W
S004	S42-4504-05	PUSH SWITCH

VOLTAGE SELECTOR UNIT

X77-1020-00

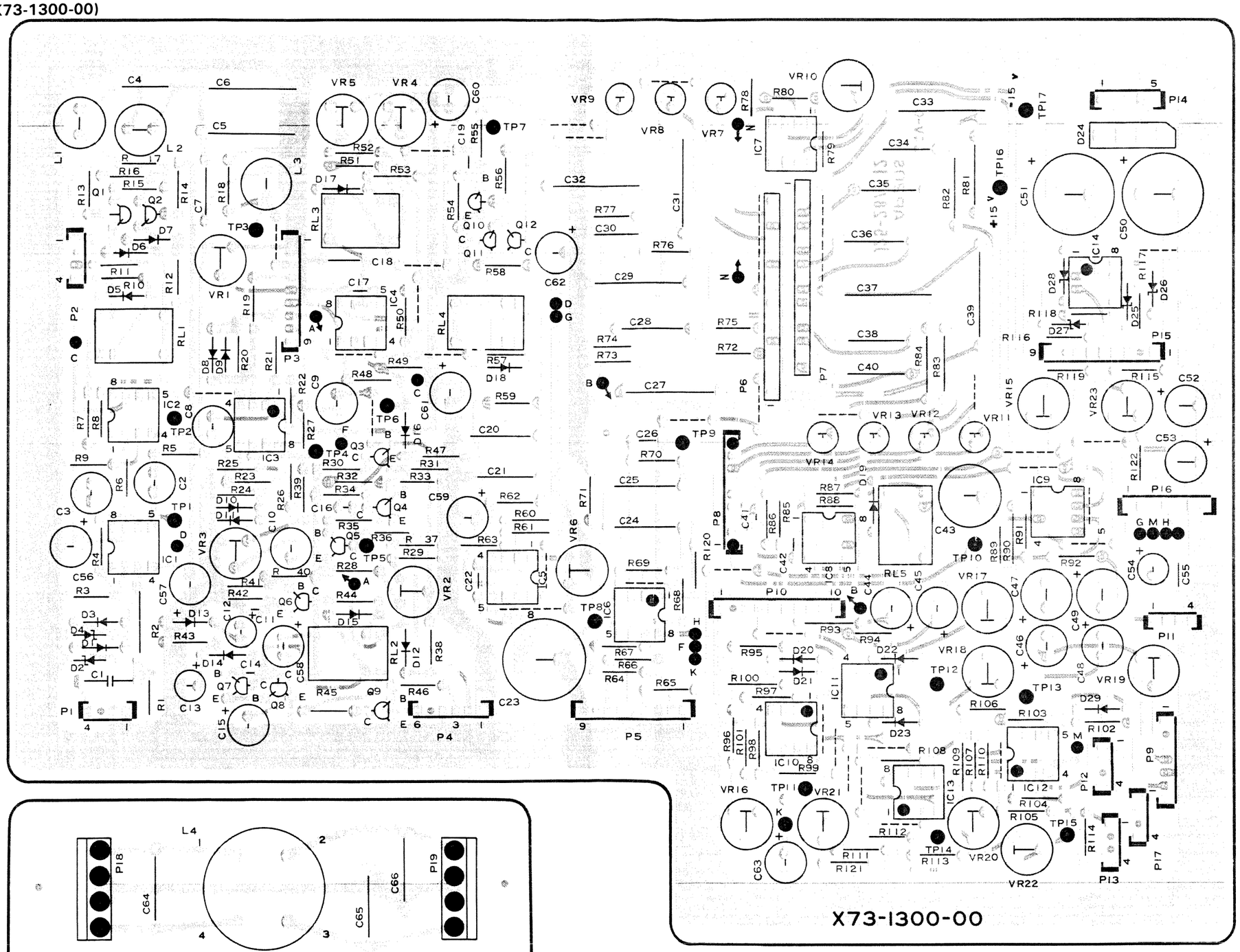
REF.NO	PARTS NO	NAME & DESCRIPTION
	E08-1081-05	VOLTAGE SELECTOR RECEPTACLE
	E09-0681-05	VOLTAGE SELECTOR PLUG
	E23-0047-04	TERMINAL
	E40-0233-05	PIN CONNECTOR 2 P
	E40-0533-05	PIN CONNECTOR
	E40-0635-05	PIN CONNECTOR
	F19-0703-04	PLATE.FOR VOLTAGE SELECTOR
	J12-0501-14	MOLDED PIN
	J25-2805-14	P.C.B.(UNMOUNTED)

SCHEMATIC DIAGRAM



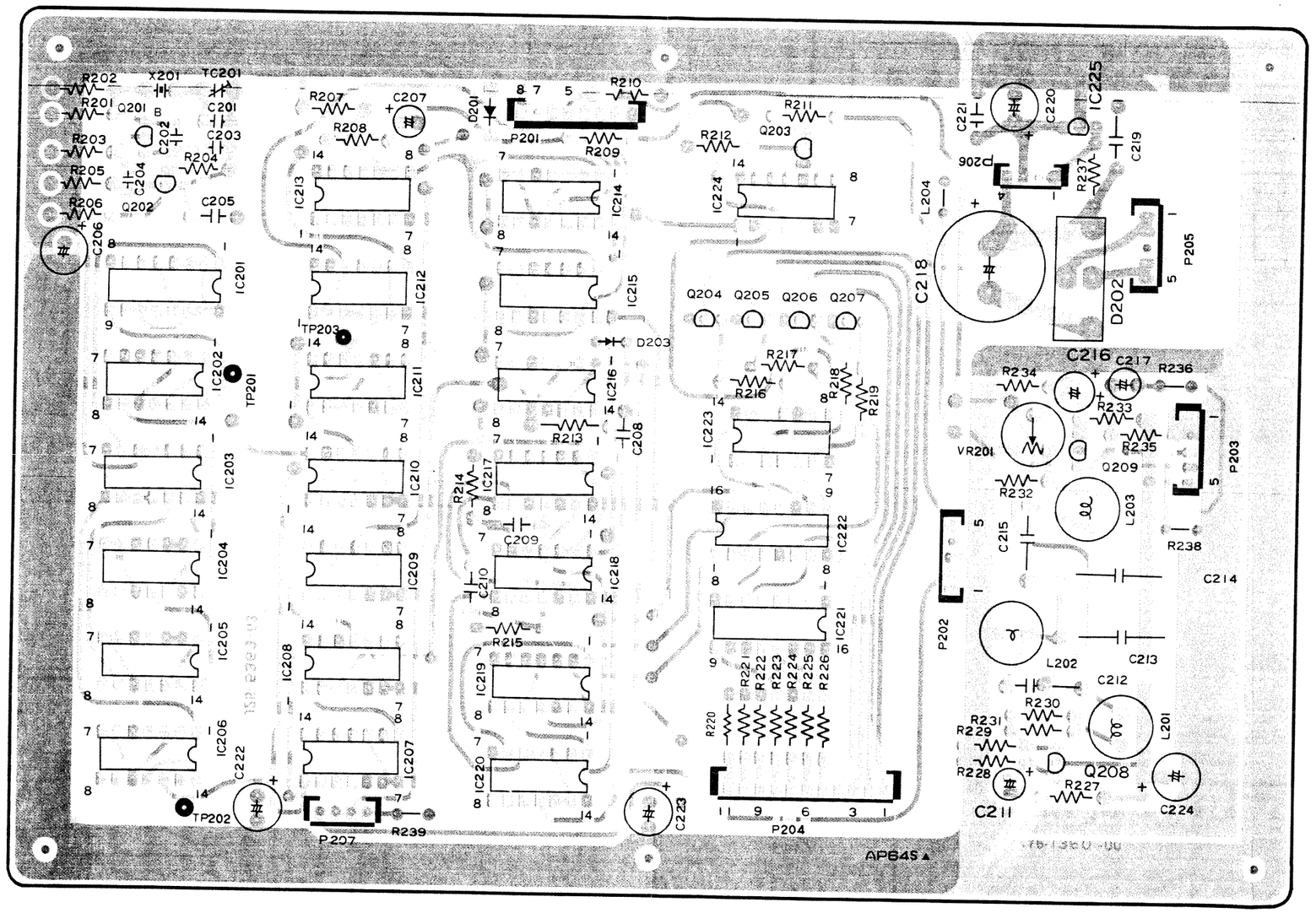
P.C. BOARD

AMPLIFIER UNIT (X73-1300-00)



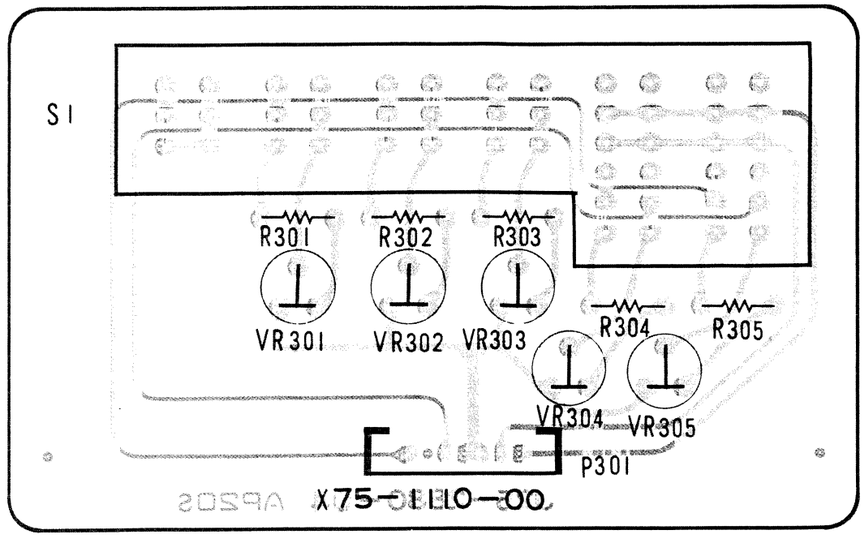
P.C. BOARD

COUNTER UNIT (X76-1360-00)



P.C. BOARD

ATTENUATOR UNIT (X75-1110-00)



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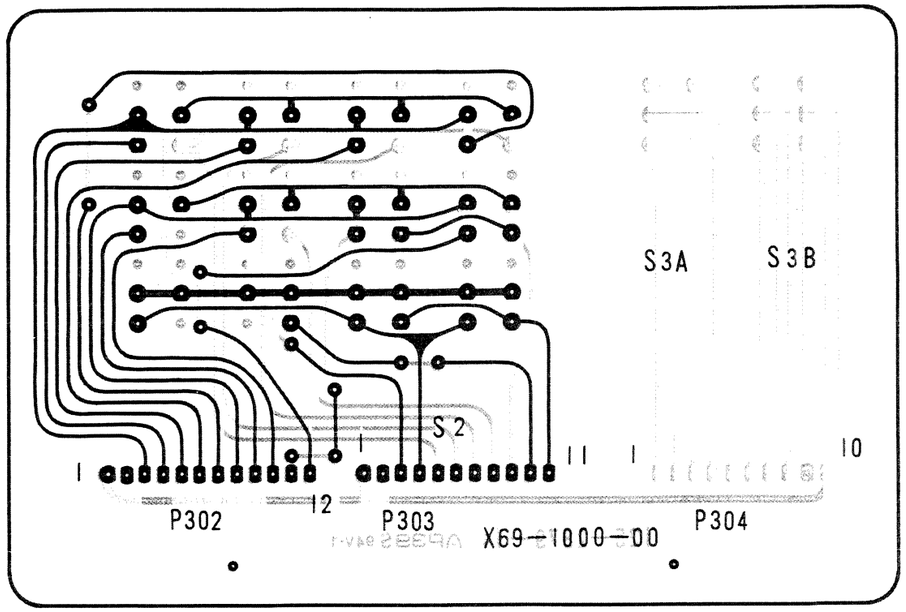
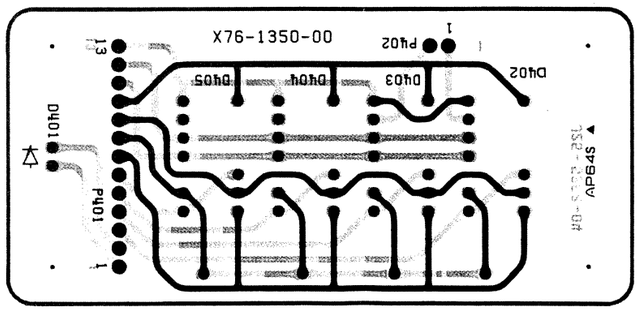
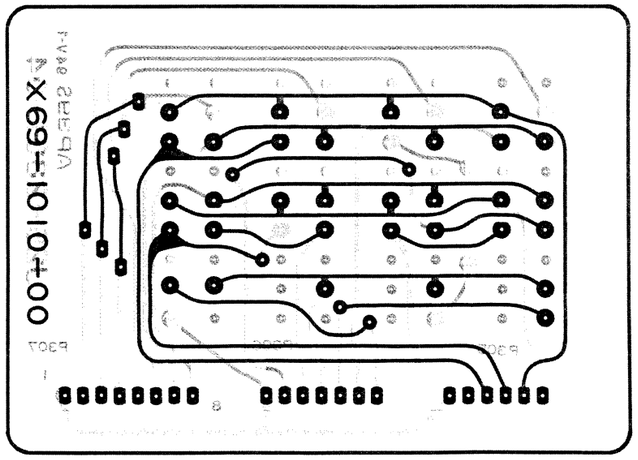


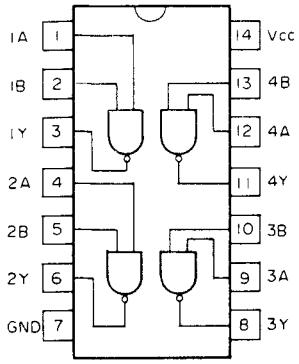
INDICATION UNIT (X76-1350-00)



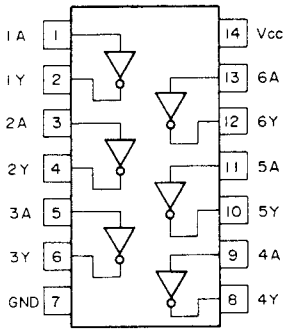
SWITCH UNIT (X69-1010-00)



SEMICONDUCTORS



SN74LSOON



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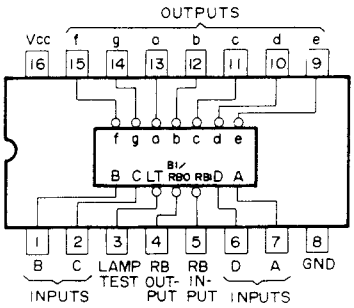
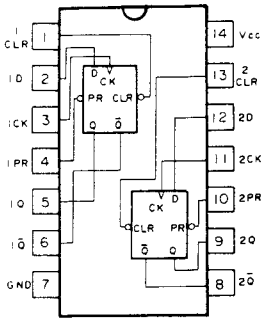

OUTPUTS
Vcc f g a b c d e
16 15 14 13 12 11 10 9
f g a b c d e
B C LT RBI RBO D A
1 2 3 4 5 6 7 8
B C LAMP TEST RB OUT- PUT RB IN- PUT D A GND
INPUTS INPUTS

SN74LS47N



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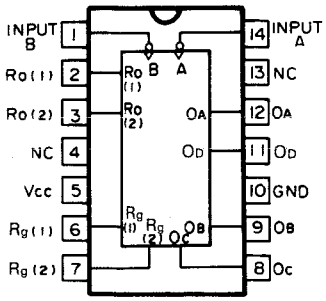

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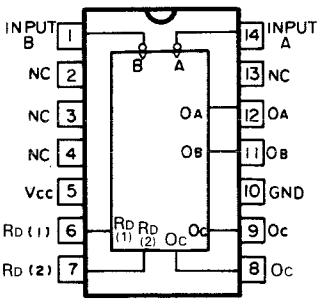

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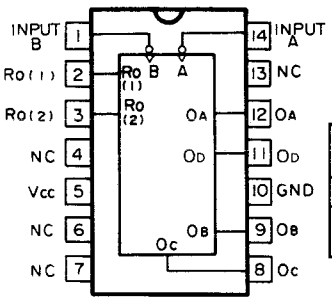
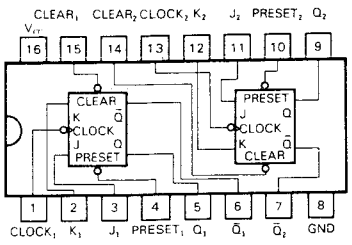
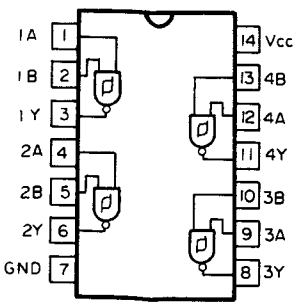


SN74LS93N



SN74LS112AN



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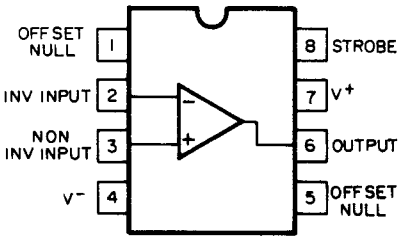

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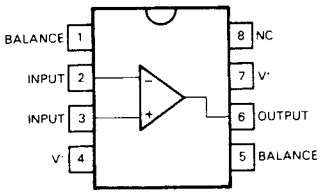

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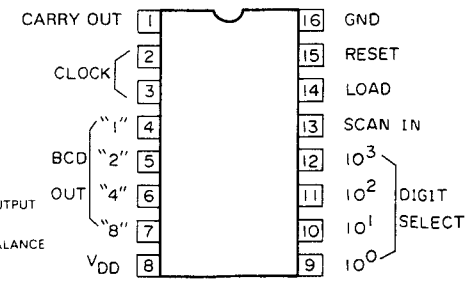
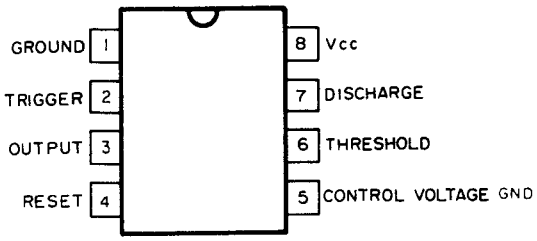


MSM5502RS

SEMICONDUCTORS



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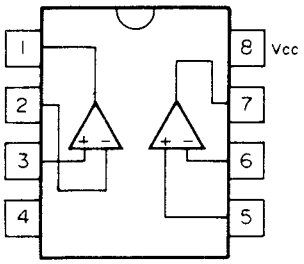

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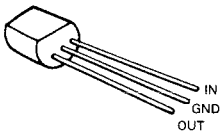

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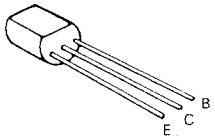

2SA733(P)
2SC945(P)